TECHNOLOGY DEPARTMENT

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1949

Power Generation and POWER PLANT ENGINEERING

For ALL Power Engineers • Steam, Electricity and All Other Power Engineering Services

COMPLETE CONTENTS

Turbine-Driven Compressors Supply Air For G-M Factory 54
By E. J. Turnbull and W. H. Ryan

How We Arc-Welded a Steel Expansion Joint 57
By Fred E. Schubert

High Voltage Motor Control 58
By R. C. Thompson

Increasing Power Plant Wash-Water By Using Wasted Condensate 60
By Leslie H. Housel

Hydrocol Process Requires 80,000 hp in Compressors 61

Power from Pike's Peak 62
By Robert M. Ormes

How to Operate Industrial Steam Turbine Oil Systems for Best Oil Performance 65
By Frank C. Linn

Power Generation News Reel 68

Here's How They Train Power Plant Operating Engineers in Cleveland .. 70

Basic Power Plant Figuring 72
By William H. Engelman

★ A Practical Thermoelectric Generator 74
By Curtiss D. Bassett

James D. Cunningham Nominated to Head ASME 77

★ How We Use Industrial Process Instruments in Power Plant Control 81
By W. H. Fortney

Is Alaska's Power Potential Being Overlooked? 88
By Richard LaCoste

Is Your Heating System Adequate and Economical? 92
By William W. Gaylord

Make Your Toggle Bolt Solid with a Sleeve 94
By Thomas Trail

The Faith of Jingles Joe 96
By John Raven

What the Dual-Fuel Engine Can Do 102

Atomics Digest 110

Regular Departments

Notes on This Issue 5

Engineers' Preview 7

Questions and Answers 78
- Why Is This Circuit Grounded Through A Fuse?
- Why Did Motor Rotor Operate Off Center?
- What Makes Turbine No. 2 Drop Load and Lose Vacuum?
- How Can He Compare Simplex and Duplex Pump Efficiencies?
- Who Can Help This Engineer Pump Cold Molasses?
- How Much Phase Unbalance Can a Generator Stand?
- With Pressure Held Constant, How Can You Increase Refrigeration?

Helpful Bulletins 36

New Equipment News 42

Construction News 98

Coming Events 116

Obituaries 116

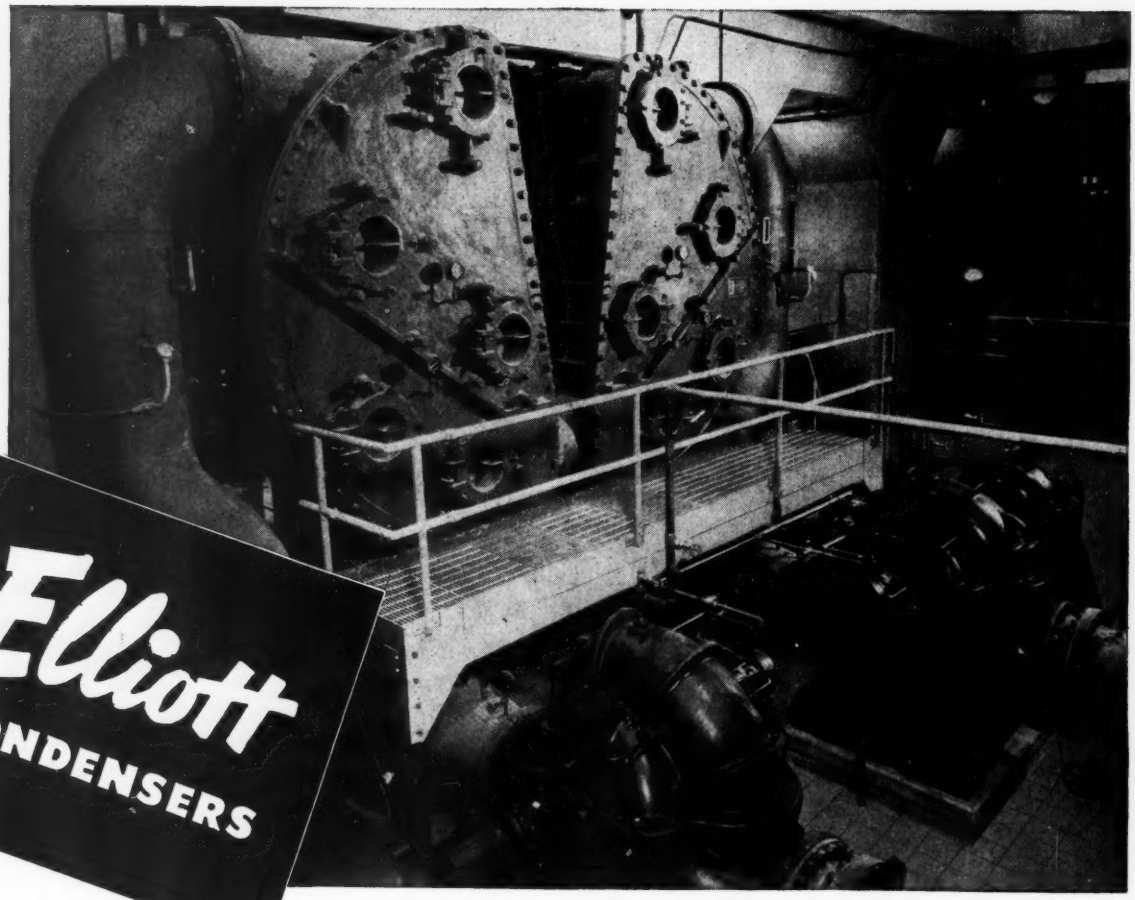
Catalog Library 118

New Engineering Books 127

Letters to the Editors 53
- Reclaimed Lubricants
- Pipe Alignment
- A Smudge

AUGUST
1949

2 big factors IN PROFITABLE



In keeping with the experience of more than thirty years, Elliott condenser design sets a high standard which is proven beyond question by many condenser installations throughout the country.

The 30,000-sq. ft. divided water-box surface condenser illustrated above is one of two serving a fine new station of an Eastern utility. The condensers are equipped with reverse-flow valves.

Elliott condenser design permits of wide modification to meet specific requirements. Condenser Bulletin C-9 at request.

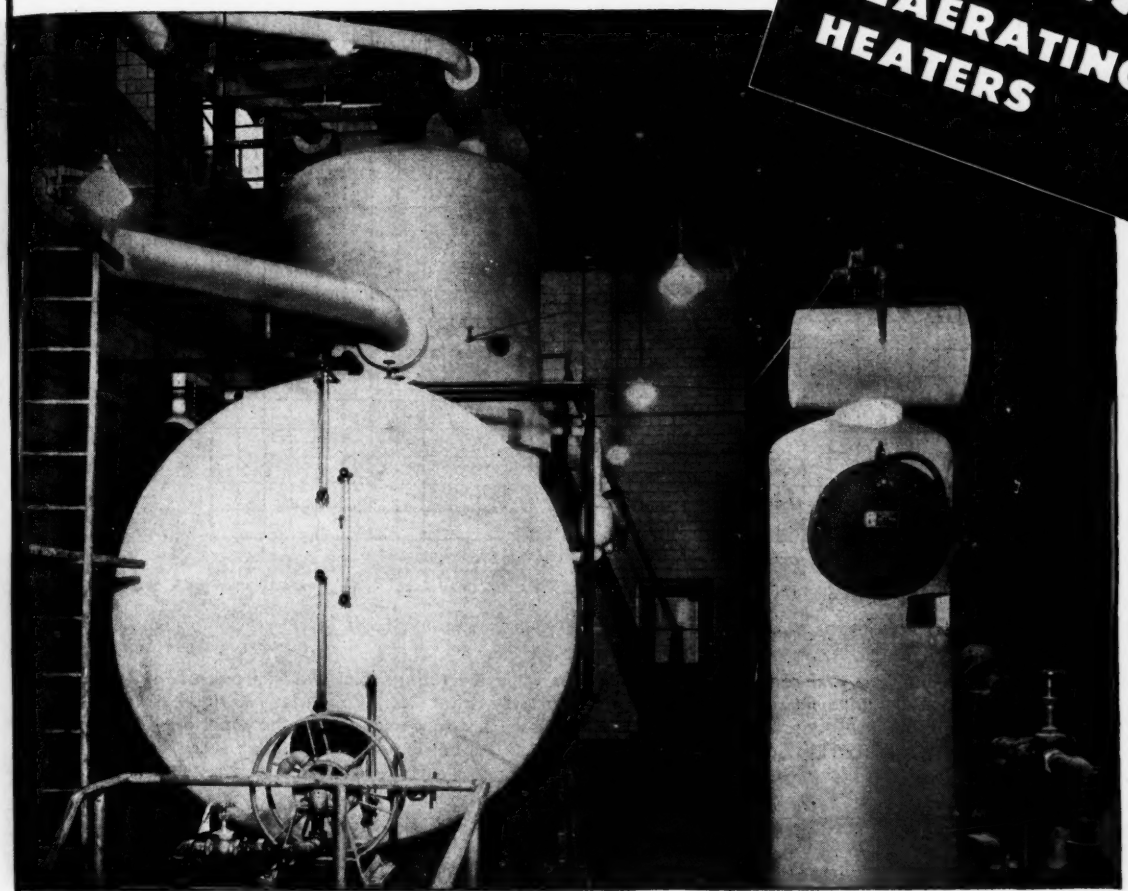
ELLIOTT COMPANY

Heat Transfer Dept. and Deaerator & Heater Dept.
JEANNETTE, PA.

Plants at: STEAM TU CENTRIF

STEAM PLANT OPERATION

Elliott
DEAERATING HEATERS



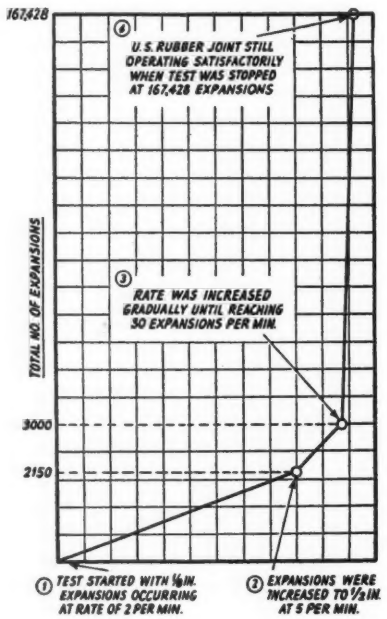
Again experience pays off. Elliott engineers pioneered in deaerating heater development, and have consistently set the pace in the design of this type of equipment, now a major essential in steam plants.

The installation above serves the same plant as the condenser on the facing page. The large horizontal storage tank is surmounted by a vertical 375,000-lb.-per-hr. deaerating feedwater heater. The vertical unit at right is a 14,000-lb.-per-hr. deaerating evaporator preheater handling make-up requirements. Bulletin N-16 gives full deaerating heater details.

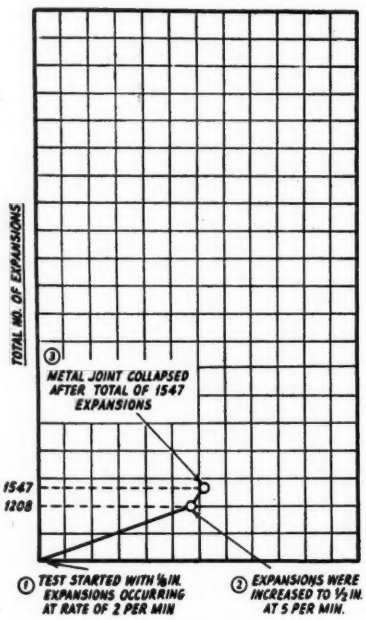
Q-1140

100 TIMES MORE ENDURANCE

Vibration tests show U. S. Rubber Expansion Joint withstands over 100 times more vibration cycles than a metal joint

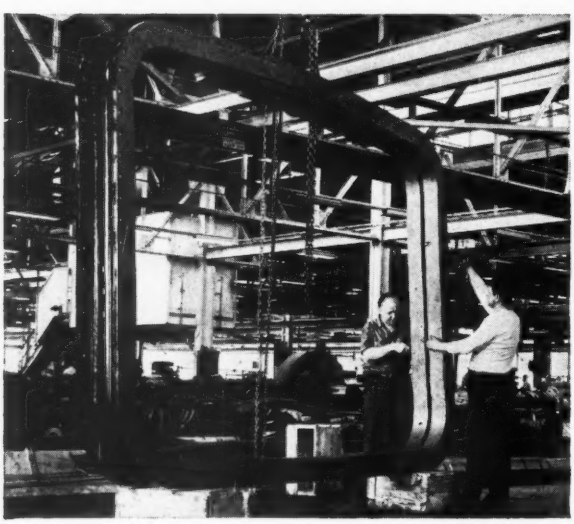

167,428
④ U.S. RUBBER JOINT STILL OPERATING SATISFACTORILY WHEN TEST WAS STOPPED AT 167,428 EXPANSIONS
TOTAL NO. OF EXPANSIONS
③ RATE WAS INCREASED GRADUALLY UNTIL REACHING 30 EXPANSIONS PER MIN.
3000
2150
① TEST STARTED WITH 1/8 IN. EXPANSIONS OCCURRING AT RATE OF 2 PER MIN.
② EXPANSIONS WERE INCREASED TO 1/2 IN. AT 5 PER MIN.

Test of U. S. Rubber Expansion Joint


TOTAL NO. OF EXPANSIONS
③ METAL JOINT COLLAPSED AFTER TOTAL OF 1547 EXPANSIONS
1547
1208
① TEST STARTED WITH 1/8 IN. EXPANSIONS OCCURRING AT RATE OF 2 PER MIN
② EXPANSIONS WERE INCREASED TO 1/2 IN. AT 5 PER MIN.

Test of Metal Joint

To determine comparative endurance, a U. S. Rubber Expansion Joint and a metal joint were subjected to the vibration tests described in the above charts. The metal joint collapsed after 1547 cycles while the rubber joint was still operating satisfactorily after 167,428 cycles. A rigorous test for shock also demonstrated the superiority of the U. S. Rubber Expansion Joint.



Large-size rectangular joint. Only U. S. Rubber has the facilities and skill to manufacture efficient expansion joints of this size and larger.

FOR OVER 26 YEARS U. S. (the original) Rubber Expansion Joints have been preventing excess stresses caused by expansion and contraction . . . insulating against vibration . . . preventing the transmission of undesirable sound.

U. S. Rubber Joints are light in weight, resistant to corrosion and erosion, require no gaskets between flanges, can stand higher working pressures. They eliminate costly repairs, increase operating efficiency and extend the life of equipment, saving many times their original cost. They are reliable. Available in both large rectangular and round types.

For more information write Expansion Joint Sales Department, United States Rubber Company, 1 Market Street, Passaic, New Jersey.

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Contents of back issues of Power Plant Engineering and Power Generation will be found in both the Industrial Arts Index and the Engineering Index on file in Public Libraries.

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Power Generation

August 1949

VOLUME 53—NUMBER 8

Notes on This Issue

Front Cover Contents

Beginning with this issue the complete table of contents has been moved to the front cover. The change is made as a result of long and careful study of the reading habits and the expressed desires of our readers. It is obvious that POWER GENERATION is not only read each month as received but is also filed for reference as specific problems arise. So it is just plain common sense to put the complete contents where it is easiest to refer to—on the cover.

So here is the improvement you readers requested. We hope you like it and we will be glad to have your comments.

A Thermoelectric Generator?

Most articles in POWER GENERATION are the practical kind you can put to work in your daily engineering operations. Once in a blue moon, however, we have the privilege of presenting a really revolutionary idea to stir the imaginations of power engineers. Mr. Bassett, a thoroughly practical consulting engineer who is now building a new power plant for Morton Salt Co. in Texas, read an article by Editor Kramer in POWER GENERATION, suggesting several schemes for extracting power from a nuclear reactor. This started Mr. Bassett thinking about the possibility of converting heat energy into electrical energy by the thermoelectric effect as has been done for many years in the field of high temperature measurements. He and Mr. Kramer have been working together on the idea for the past four months.

No one can say whether a thermoelectric generator can be made successful until an actual experimental plant is built, but we have jet planes and television. Who knows, this may be the germ of something important.

Alaska's Power Potential

Power engineers have a professional interest in power resources. You'll enjoy reading about the great undeveloped hydro-electric potentials in Southeast Alaska and the pictures are good.

Those Turbine Oil Articles Again

This series, which started in April, is concluded in this issue. The reason it has stirred up so much interest among readers, lubrication engineers and turbine oil companies, is that much of the information has never appeared in article form. It is planned to reprint the complete series in a booklet. If you are interested in reprints, drop us a post card telling us how many and we'll give you prices.

The Dual-Fuel Engine

Power Engineers are always on the lookout for versatility in equipment, and many readers will see possible solutions to some fuel problems in the recently developed gas Diesel and Dual-Fuel engines. You can switch from gas to oil or vice versa as fuel supply or prices make it desirable.

Read this article for data on relative costs of operation with gas and oil—performance under partial load—and details of valve and governor mechanism.

Industrial Process Instruments in Power Plants

This one may stir up a bit of controversy, which is always stimulating. Mr. Fortney has some unorthodox ideas about instruments but he is in charge of a very large instrument department for Humble Oil Co. and can back up his arguments and methods with performance figures.

Turbine Driven Compressors Supply Air for G-M Factory

Generation of electricity is only one phase of power engineering. The Ternstedt factory of G-M for example, has a complete, modern power plant in which no electricity is generated. Two 70,000 lb per hr integral furnace boilers operate at 215 psi. Three large air compressors (2731 cfm) supply the huge quantities of compressed air required. Two are driven by steam turbines and the third by motor so heat balance can be adjusted. Exhaust steam from the turbines heats the entire 640,000 sq ft of factory space.

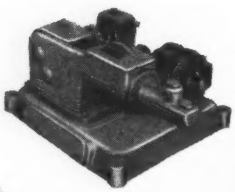
CHEMICAL TREATMENT METERING PUMPS

for Every Power Plant

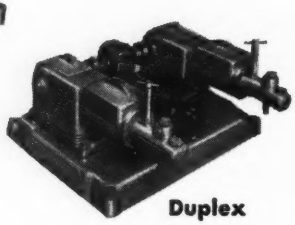
PLUNGER TYPE PUMPS FOR HIGH PRESSURES

DIAPHRAGM TYPE PUMPS FOR LOW PRESSURES

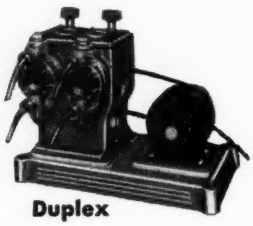
FROM THE SMALLEST JOB



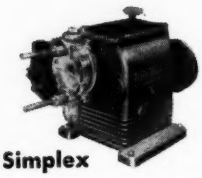
Simplex



Duplex



Duplex

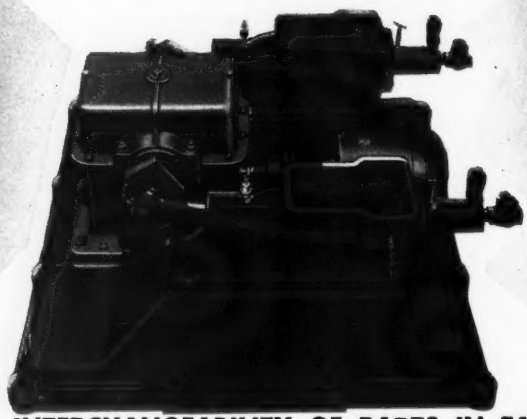


Simplex

Also available in Triplex and Quadruplex designs

Also available in Triplex and Quadruplex designs

TO THE LARGEST HIGH PRESSURE INSTALLATION



COMPLETE INTERCHANGEABILITY OF PARTS IN EACH GROUP

NEW MODELS NOW AVAILABLE

• HEAVIER FRAMES • LARGER WRIST PINS • EXTRA HEAVY NEEDLE BEARINGS AND PUSH RODS • STUFFING BOXES SPECIALLY DESIGNED FOR INTERCHANGEABLE STANDARD PACKINGS OR TEFLON SEALS

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ENGINEERS' PREVIEW

A NEW ILLUSTRATED BOOK, entitled "Steel Making in America", is being distributed by United States Steel. The 100-page volume was prepared and published in response to thousands of requests annually from school students and others for up-to-date information about steel-making.

It is being sent to science teachers, writers and editors, public libraries, high and junior high schools and junior colleges throughout the country. The book describes in simple language the manufacture of steel in the United States from raw materials through finished steel products of every sort. A brief history of the iron and steel industry from earliest days to the present time also is included.

★ ★ ★

TELEVISION to obtain remote, rapid, qualitative evaluation of combustion efficiency was proved practicable during recent tests conducted by RCA engineers on ram jet aircraft engines. Other experiments made with an infra-red-sensitive image orthicon tube showed that a television system can see "hot spots" in metals before they become visible to the human eye. The monitor picture began to show distinctive light grey spots on a locally-heated plate of steel well before the eye could detect any red coloring on the plate itself.

★ ★ ★

SCIENCE is, and must remain, a strong unifying force among peoples, according to Dr. Foster Dee Snell, chemical consultant of New York, in accepting the gold medal of the Society of Chemical Industry at its meeting in Manchester, England, July 13. This is the second time in its 53-year history that this important medal has been awarded to an American. "Scientists around the world," Dr. Snell said, "have always been leaders in international friendship, and have always been willing and eager to promote the exchange of information internationally. This is the way it should be. Let us hope that such artificial barriers as may be raised from time to time against free interchange will be only temporary, so that scientists may continue a strong unifying group among the peoples of different countries."

★ ★ ★

WITH THE COMPLETION of a new laboratory area and the enlargement of its electrical engineering staff, Battelle Memorial Institute, Columbus, Ohio, has embarked upon a program of research in electrical engineering. The step is aimed at providing adequate research facilities for companies not equipped to conduct research on complex electrical engineering problems. Battelle studies in electrical engineering will include circuits, electrical machines, instruments, servomechanisms, analogue computors, ultrasonics, X-rays, electromagnetic fields, high-frequency equipment, materials testing, development of electrical conducting and magnetic materials, the design of systems involving nonlinear magnetic and semiconductor circuit components, and illumination. Research in these and related subjects will be available to industry on a cost basis. Battelle also conducts investigations in industrial electronics, physical electronics, wear and lubrication, surface phenomena, mechanics, hydraulics, and other branches of applied physics. Dr. Robert C. McMaster is in charge of Battelle research in electrical engineering.

O-O-O-O-W! That stands for a "howler," as editors call it — some horrible mistake that gets through despite the checking and cross-checking and back-checking of proof-readers, editors, make-up men and more proof-readers. Several came through in the July issue.

Right on page 53, the first page of the main editorial section, was "*Steam*, published by The Babcock & Wilson Co." Anybody should have known that was meant to be The Babcock & *Wilcox* Co.

Again—how did that credit in the caption of Fig. 2, page 102, get through as Power Service & Engineering Co. when it is given correctly in Fig 3, right next to it, as Pioneer Service & Engineering Co?

One of the worst howlers of all was the insertion of a corrected, reset linotype slug in the wrong place in E.P. June, page 7, Needless Digits, Line 9. That entire sentence was originally written: "But, apparently, power engineers need some relaxation from their continual concentration on the little, hard, round facts of their profession."

We bow our crimson visage in shame and repeat "O-o-o-o-W! How did those get in there?"

We often feel like the French-horn player in the symphony orchestra who "blew a bubble" and played a wrong note, producing a tremendous discord right in a particularly important passage. Scolded by the conductor after the performance, the player said "Ach! Maestro, I put it in so s-v-e-e-e-t—und it come out so so-o-u-r!"

★ ★ ★

ARTHUR E. FOCKE, research metallurgist for the Diamond Chain Co., Indianapolis, Ind., will be the next president of the American Society for Metals, according to an announcement made today by W. H. Eisenman, Executive Secretary of the Society. He will take office on October 19, at the annual ASM meeting during the 31st National Metal Congress and Exposition in Cleveland, Ohio. The new president-designate was born in Cleveland, Ohio, and educated in the public schools of Cleveland and Columbus. He is a graduate of Ohio State University, receiving his master's degree in Physics and Metallurgy in 1936. He also received his doctor's degree in Mining and Metallurgy from Ohio State.

★ ★ ★

SERENDIPITY:—On the chance that serendipity is not in your conversational vocabulary or that its meaning has slipped from your memory, we want to bring it to your attention. It is a word everyone engaged in industry should know, because it means the "gift of finding valuable or agreeable things not sought for." A great many important discoveries have been made while the researcher sought for something else—often entirely removed from what he found. The art of recognizing something new and important when you happen on it is what makes the difference between the average researcher and the eminent one. Keep your eyes and ears open and you may have a serendipitous experience in a new job, with a new friend, or on a trip. Hugh Walpole coined it in allusion to a tale, *The Three Princes of Serendip*, who in their travels were always discovering by chance, or by sagacity, things they did not seek.—*Refrigerating Engineering*, June, 1949.

THE GOVERNMENT needs highly qualified engineers and scientists for work in the field of their greatest competence. A new file in Washington is now being accumulated to contain 100,000 questionnaires now on the way to professional engineers and scientists. As a source file of key engineering personnel, this roster will aid tremendously in solving a variety of national technical personnel problems. National resources of technical personnel can be ascertained. In emergency, the file can be used to minimize disturbance to the national economy. Military defense has become a composite of highly intricate sciences. It needs the brains of the best men in every scientific and engineering field. The best men often have not been employed at their specialties.

Now, the Scientific Personnel Branch of the Office of Naval Research (ONR) has been assigned by the Secretary of Defense to be the referring office for scientific uniformed and civilian employees. This Branch called a large meeting last Fall in Washington attended by representatives of many engineering societies. Several representatives of the Engineers Joint Council (EJC), an organized group of five professional engineering societies, attended. EJC agreed to sponsor officially a "Survey of Selected Engineering Personnel" and has obtained the cooperation of 18 prominent engineering societies that maintain a full professional grade of membership. EJC assigned The American Society of Mechanical Engineers (ASME) as contracting agent under an ONR agreement.

The survey is managed by the EJC Committee. C. E. Davies, Secretary of ASME, is Chairman, and R. A. Wentworth, member of ASME, is survey director. As the questionnaire will provide the key of opportunity to professional and patriotic service, ONR through EJC urges engineers and scientists to give serious attention to answering all questions fully.

★ ★ ★

ARCHEOLOGISTS have unearthed part of the foundations of the furnace where the first iron was made in the United States more than 300 years ago, American Iron and Steel Institute has announced. The location is on the right bank of the Saugus River, a few miles from Lynn, Mass. Further digging is going on.

The foundations of the 1643 plant are being located and correlated. Details of the plant construction are being assembled from all possible sources bearing upon the contemporaneous records of that period here and abroad. When all the data are at hand and authenticated, the work of reconstruction will begin, to the end that the First Iron Works will be accurately reproduced on the original site.

It is hoped that sometime in 1950, the project can be completed and established as a public museum; a permanent monument to the beginning of iron and steel production on this continent.

★ ★ ★

EIGHTEEN DAMS over 50 ft high are currently under construction in Mexico to increase the irrigable area of the country, J. Vicente Orozco, chief engineer of the Irrigation Division of the Ministry of Hydraulic Resources of Mexico, told members of the ASCE at their summer convention. These new dams, when completed, will add about 850,000 acres to the land now under cultivation, Mr. Orozco said. Also, three of the new dams, where power will be produced, will add some 200,000,000 kwhr to the nation's yearly hydroelectric power output.

A SUCCESSFUL METHOD for the flame spraying of polythene on metal surfaces has been developed by the Engineering Research Laboratory of the Du Pont Co. Polythene is unusually inert and thus is highly resistant to corrosion. Because of this characteristic, the material is particularly attractive as coatings for metal surfaces, such as tanks and drums, where corrosion is a factor. However, polythene has been difficult to apply by conventional methods because of its relative insolubility.

The sastisfactory method now developed was accomplished by devising a spray gun in which the flame is obtained by mixing the fuel gas and the air needed for combustion beyond the torch nozzle, rather than by premixing them. Flames 8 to 12 in. long are used and the gun is held so that the surface to be covered is about 2 in. from the tip of the flame. The surface must be pre-heated to 400 to 500 F and small quantities of finely powdered graphite or carbon black promote adhesion. By this method, approximately 116 sq ft per hr can be covered.

Tests indicate that adhesion is good and that the temperatures used do not degrade the polythene. Exposure tests of 300 days' duration with sulfuric, hydrochloric, and other acids have shown no deterioration in coating properties or base metal attack.

★ ★ ★

BASIC MARKETING Chart of the United States, 1949 edition, a compilation of workable data designed to facilitate analyses of current business conditions and trends, has been released by A. Edwin Fein, general manager of the Research Company of America. The chart shows that the civilian population for the United States as a whole increased 11.0 per cent between 1940 and 1948. Income of Americans jumped from $76 billion ($575 per capita) in 1940 to $190 billion ($1,323 per capita) in 1947, an increase of 150 per cent. Life Insurance sales per capita jumped from $50 in 1940 to $99 in 1948. Of all families, 94.2 per cent in the United States own radios, and 63.0 per cent enjoy home telephone service. The chart shows an estimate of retail sales for 1948 in excess of $130 billion for the nation as a whole. Gross Farm Income exceeded $30 billion in 1948, and 18.5 per cent of the labor force was employed in this activity. Americans paid more than $20 billion income taxes. Number of manufacturing establishments rose from 173,802 in 1939 to 240,801 in 1947, according to figures compiled from data recently released by the Census Bureau.

Importance of such basic data to power engineers, who supply the kilowatt-hours behind all this, should be self-evident.

★ ★ ★

GRAND COULE DAM in Eastern Washington increased its lead in July as the foremost power producer in the world when its 11th giant generator went into commercial service. As the new unit went into action, the installed rated capacity of the Bureau of Reclamation power plant reached the immense total of 1,208,000 kw. Its peaking capacity is expected to be approximately 1,400,000 kw because the generators can carry loads far in excess of their "nameplate" ratings of 108,000 kw each, when water conditions are favorable. The newest generator is R-2, second of nine to be completed in the East Powerhouse on the Columbia River. Work is progressing satisfactorily on R-3, the third East Powerhouse generator, and it will be operating this fall to swell the dam's installed rated capacity to 1,316,000 kw.

Fact File on Preheat

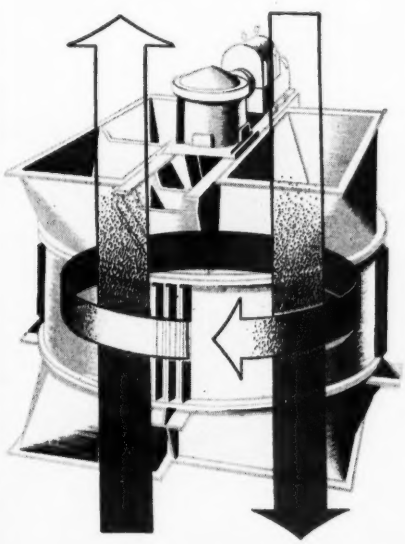
No. 4

The free area of the gas and air passages through the Ljungstrom heating elements is maintained at design levels by a simple cleaning routine, accomplished during operation.

A high-velocity jet built in the cold end of the unit moves radially across the rotor elements, cleaning them of soot or fly ash.

In service — as in design — our engineers apply for your benefit 26 years of experience gained at Ljungstrom-equipped plants.

LJUNGSTROM



The Ljungstrom Air Preheater is a compact gas-to-air or gas-to-gas heat exchanger, operating on a continuous regenerative counterflow basis. Hundreds of leading power plants and other special applications confirm its high level of heat recovery and long-term low maintenance service.

THE

AIR PREHEATER CORPORATION

60 EAST 42ND STREET · NEW YORK 17, N. Y.

Plant: Wellsville, N. Y.

1806

Yarway Type B Seatless
Tandem Blow-Off Valve.
For pressures to 400 psi.

YARWAY

THEY KEEP BLOW-DOWN LINES TIGHT IN OVER 15,000 PLANTS

Yarway Blow-Off Valves are known in almost every plant where boilers are used to generate steam.

Why this thorough acceptance? Partly because the Yarway *Seatless* feature eliminates the commonest source of blow-off valve trouble. In Yarway *Seatless* Valves there are no seats to score, wear, clog and leak.

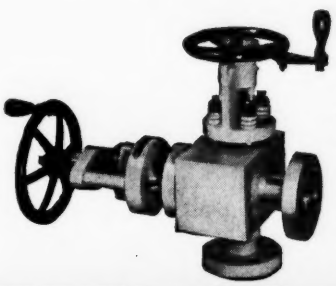
Partly because of Yarway's advanced designs—such as the Unit Tandem for high pressure work. This valve combines a Yarway *Stellite-Seat* Valve (for blowing) with a Yarway *Seatless* Valve (for sealing) in a solid, one piece forged-steel body.

And finally the dependable, trouble-free service of Yarway Blow-Off Valves prompts power plant engineers to insist on Yarways.

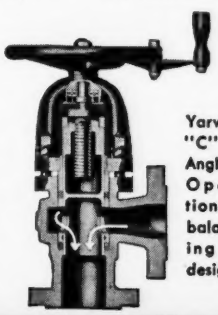
Regardless of the reason, the fact remains that today Yarway Valves are on the job—doing a good job—in more than 15,000 plants. How about yours?

Write for Bulletin B-424 for pressures to 400 psi. For higher pressures ask for B-432.

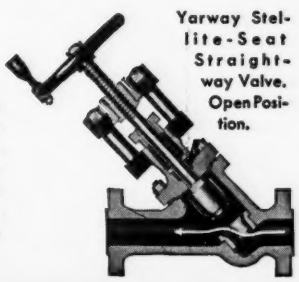
YARNALL-WARING COMPANY
114 Mermaid Avenue, Philadelphia 18, Penna.



Yarway Unit Tandem Blow-Off Valve. Flanged type. Also available with welding ends. For pressures up to 2500 psi.



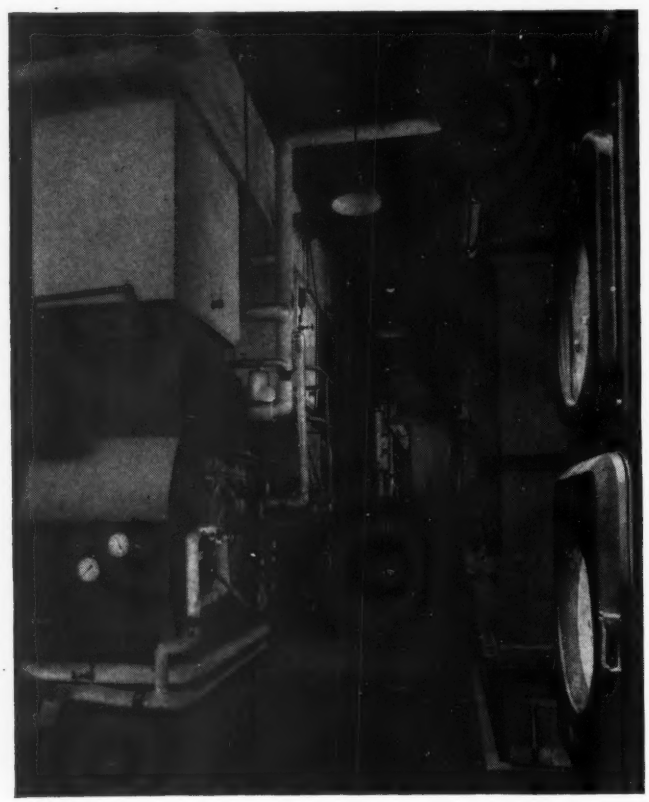
Yarway Type "C" Seatless Angle Valve. Open position. Notice balanced sliding plunger design.



Yarway Stellite-Seat Straightway Valve. Open Position.

Three-fuel boilers, with HAGAN at ALAN WOOD STEEL COMPANY

The two new boilers in the Blast Furnace division of the Alan Wood Steel Company, Conshohocken, Pa., were designed to use blast furnace gas when it is available, coke oven gas when there is an unsold surplus, and Bunker C fuel oil when necessary.



General view of boilers. H. M. Wilson Co., Philadelphia engineering and construction firm were consulting engineers on this installation.

Each boiler has a capacity of 150,000 lb./hr. They are presently operating at 165 p.s.i., but are designed for operation at 700 p.s.i. to meet future requirements.

Heat content of the blast furnace gas is approximately 90 B.t.u.'s per cubic foot; of the coke oven gas, 540 B.t.u.'s per cubic foot; and of the fuel oil 150,000 B.t.u.'s per gallon. Blast furnace gas pressure varies from 5″ to 25″.

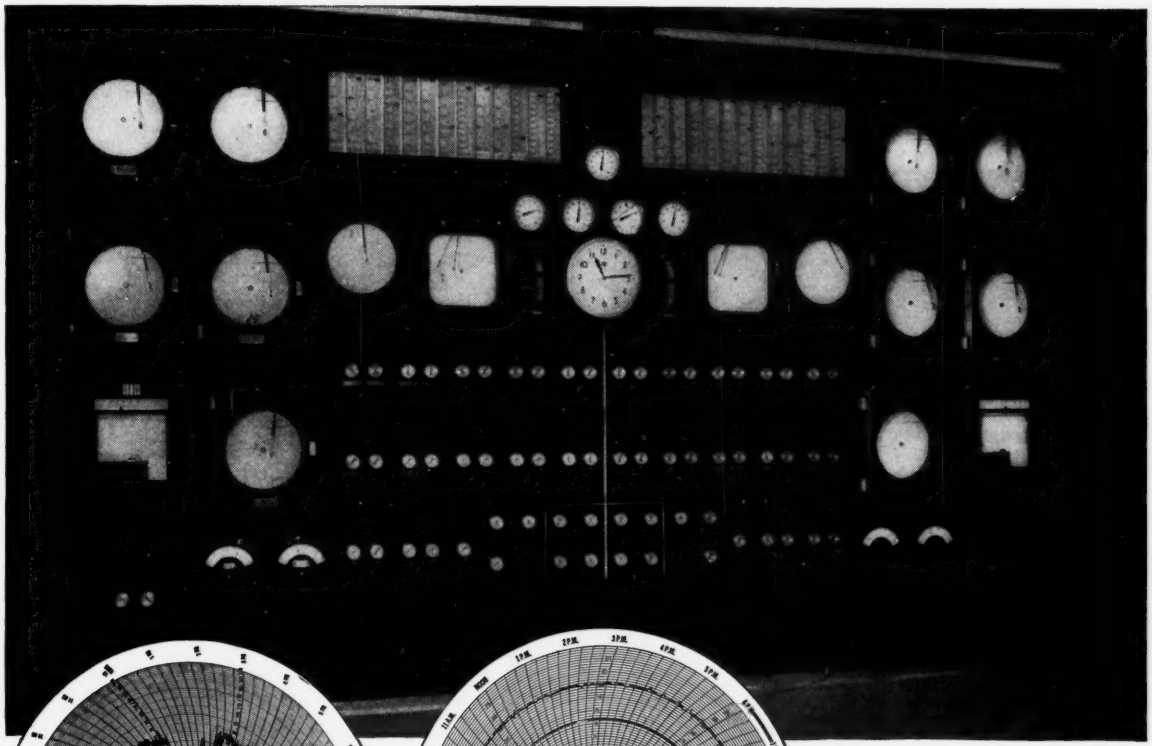
In spite of these variables, and of wide swings in steam load, the proper air-fuel ratio and the desired steam pressure are automatically maintained by the Hagan Differential Master system of combustion control.

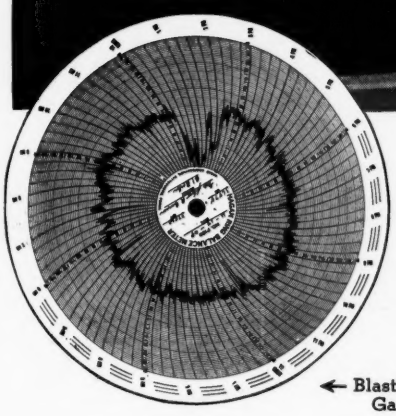
Two fuel combinations are employed—blast furnace gas and oil, and coke oven gas and oil. Changes from gas to oil and oil to gas are automatic, but selection of the type of gas to be used is, in this installation, made manually. The charts reproduced at right show how the oil "takes over" to compensate for any deficiency in gas supply.

The Hagan Ring Balance Meters shown on the panel are used to measure and record gas flow, steam flow, and boiler water level. Two others, mounted on separate panels, measure flow of coke oven gas to the pilot burners.

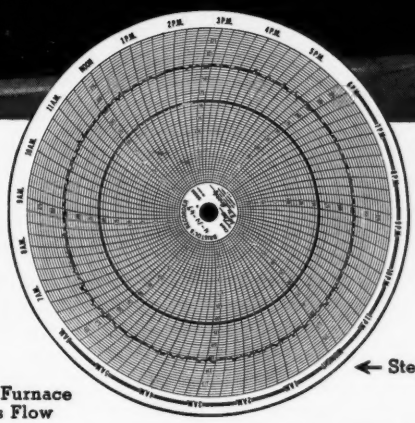
For full information on Hagan Control and Hagan Ring Balance Meters, write to Hagan Corporation, Hagan Building, Pittsburgh 30, Pa.

Controls and Meters



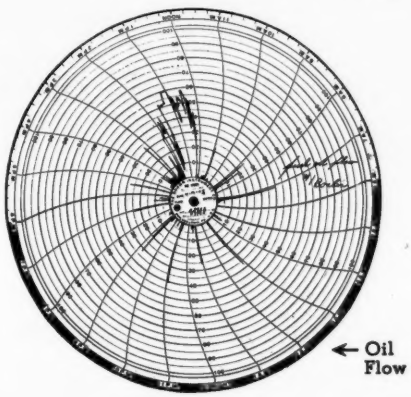


← Blast Furnace Gas Flow



← Steam Header Pressure (inner record)

▲ Control Panel of Hagan Differential Master installation at Alan Wood Steel Company. Ten Hagan Ring Balance Meters are mounted on the panel, two more are mounted on separate panels.



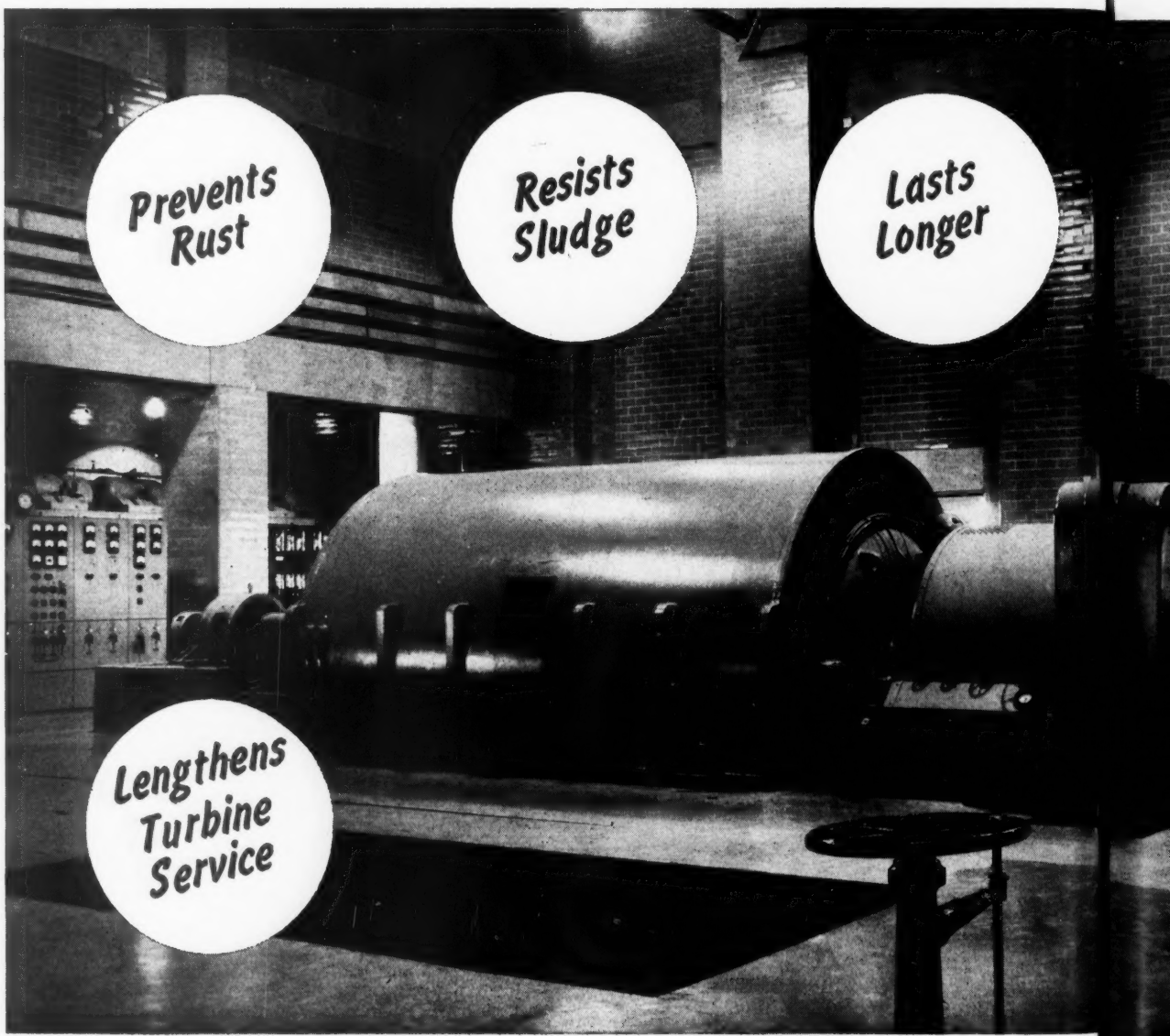
← Oil Flow

Upper chart at left shows gas flow in one burner. "Valleys" in this chart are matched by peaks in the lower chart (oil flow). For the most part, it will be noticed, these "oil on" periods are of brief duration, but the charts show one period of several hours during which gas was off. The inner circle of the chart at the right shows how the Hagan Control maintained steam pressure under these conditions.

HAGAN CORPORATION

BOILER COMBUSTION CONTROL SYSTEMS
RING BALANCE FLOW AND PRESSURE INSTRUMENTS
METALLURGICAL FURNACE CONTROL SYSTEMS
THRUSTORQ FORCE MEASURING DEVICES

Sinturlite Oils Retard Uninterrupted



SINCLAIR

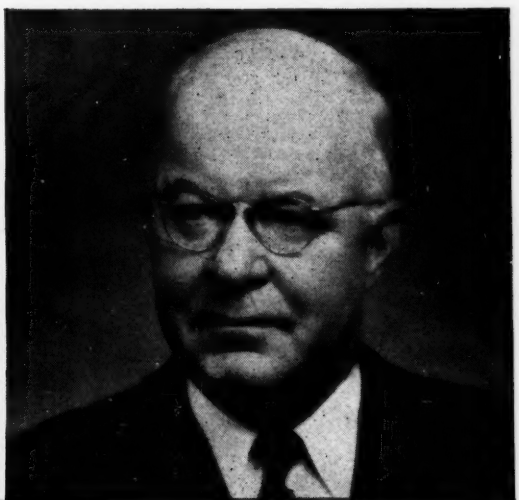
YOUR NEAREST SINCLAIR AGENT WILL GLADLY ARRANGE

Oxidation To Give Steam Turbine Service

One of the problems in steam turbine operation is the build-up of acidity in the lubricant due to oxidation. This causes harmful sludge to clog passages and impair the proper functioning of the governor.

This problem is solved when Sinclair SINTURLITE OILS are used. SINTURLITE OILS are fortified to resist oxidation and resultant acidity, retarding the formation of sludge. Other additives protect against rusting. The system is always clean, including the oil lines, bearing clearances and intricate governor mechanism. Try Sinclair SINTURLITE OILS.

Continual research explains the high quality of SINTURLITE and other Sinclair Oils. Sinclair has recently completed at Harvey, Ill., one of the most modern and complete laboratories for petroleum research and development.



E. W. Isom, Sinclair Vice-President in Charge of Research says: "With the new facilities now made available to us at Harvey, Ill., we expect to find many ways to help industry cut costs through better petroleum products."

INDUSTRIAL OILS

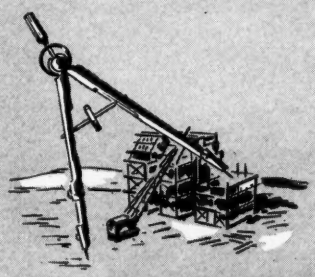
FOR LUBRICATION COUNSEL, OR YOU MAY WRITE TO SINCLAIR REFINING COMPANY, 630 FIFTH AVE., NEW YORK 20, N. Y.

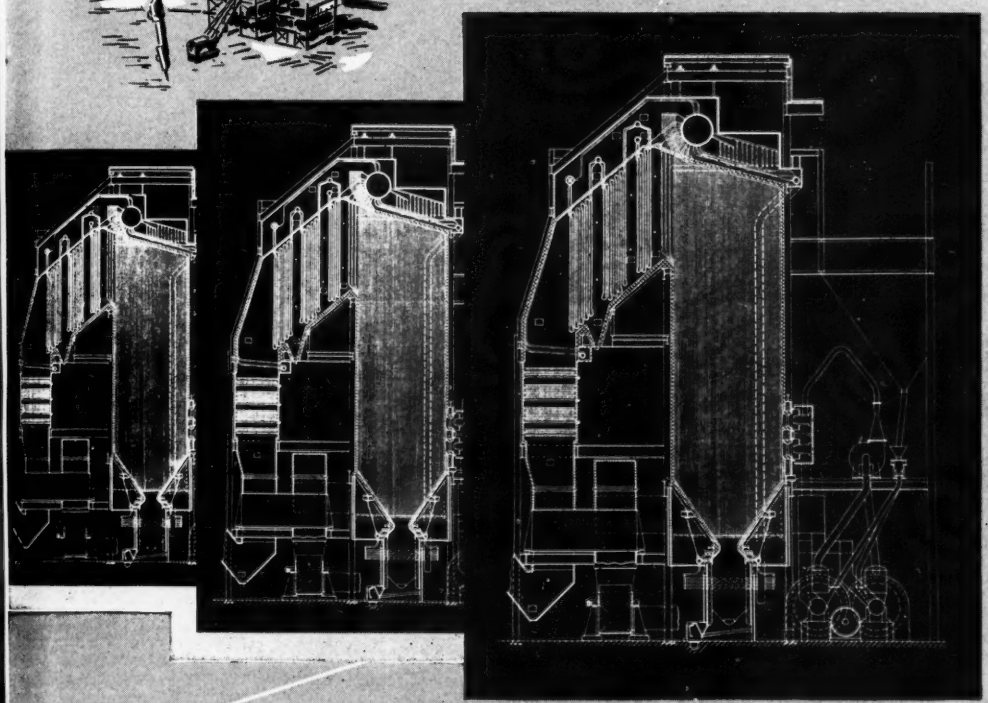
. . . AND A THIRD

LOWER VIEW: Preparing foundation for two 450,000 lb per hr steam generators at Columbus and Southern Ohio's E. M. Poston Station, South Athens, Ohio.

UPPER VIEW: The two FW units under construction.

UNIT ON THE WAY





A DESIGN WHICH PROMISES FIRST COST SAVINGS AND LONG RANGE ECONOMY

Two Foster Wheeler steam generators with a combined steam capacity of 900,000 lb per hr are now being erected at Columbus and Southern Ohio's E. M. Poston Station, located at South Athens, Ohio.

A third and larger unit of the same design, recently ordered, will have a capacity of 625,000 lb of steam per hr.

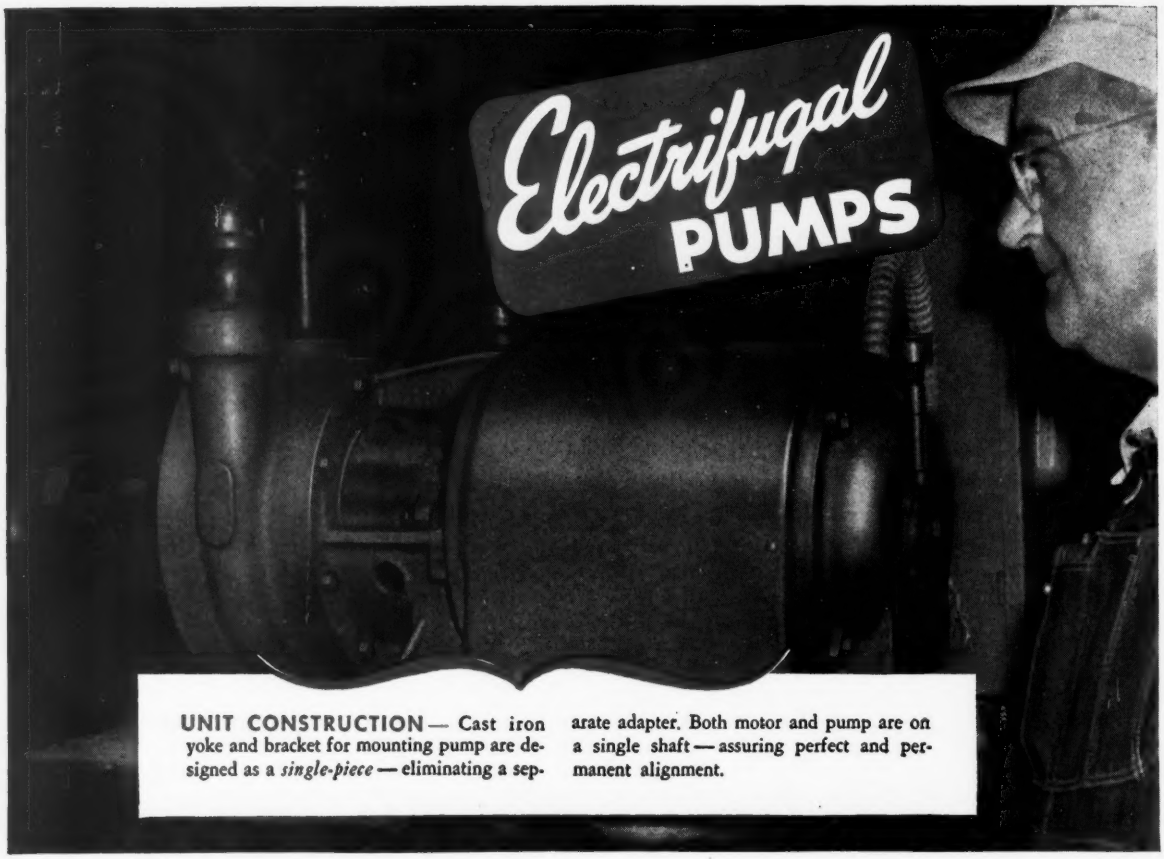
These units are typical of the single-pass design which Foster Wheeler is using as the basis for "Preferred Standard" steam generators. This standardized steam generator pattern with fixed individual equipment details may be readily applied to a series of single or twin furnace units, varying in capacity from 300,000 lb of steam per hr to over 1,000,000 lb per hr. The design also embodies Foster Wheeler features of slag-free furnace arrangement, Foster Wheeler condenser-type steam temperature control, low draft loss, and efficient heat recovery equipment.

FOSTER WHEELER CORPORATION
165 BROADWAY, NEW YORK 6, N. Y

Third Foster Wheeler Unit for
E. M. Poston Station
of
Columbus and Southern Ohio Electric Company

Capacity	625,000 lb per hr
Superheat control range	450,000 to 625,000 lb per hr
Pressure superheater outlet	1350 psi
Final steam temperature	955 F
Bituminous coal pulverized in FW ball mills	

FOSTER WHEELER



UNIT CONSTRUCTION — Cast iron yoke and bracket for mounting pump are designed as a *single-piece* — eliminating a separate adapter. Both motor and pump are on a single shaft — assuring perfect and permanent alignment.

How Unit Construction Cuts Your Pump Costs

In Installation — Installation is easier, quicker because pump comes ready to connect and run. No alignment problems. No extra parts. Easy to handle. Requires small space.

In Operation — Pump and motor, designed together to give high efficiency. Every unit tested at the factory and guaranteed to deliver rated capacity.

In Maintenance — Cannot get out of alignment. Parts easily accessible. Has fewer parts and fewer machined fits. Bronze wearing ring protects casing from wear and is easily replaced when required.

The *Electrifugal* pump, ranging from 10 to 1600 gpm with heads to 525 feet, is just one of many types of pumps built by Allis-Chalmers for industrial service. You can depend on the recommendations of the A-C pump application engineer to give you dependable service at lowest cost. For information, see your Allis-Chalmers Authorized Dealer or Sales Office, or write for Bulletin 52B6059E. A-2768

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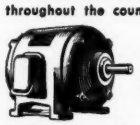


MOTORS — ½ to 25,000 hp and up. All types.

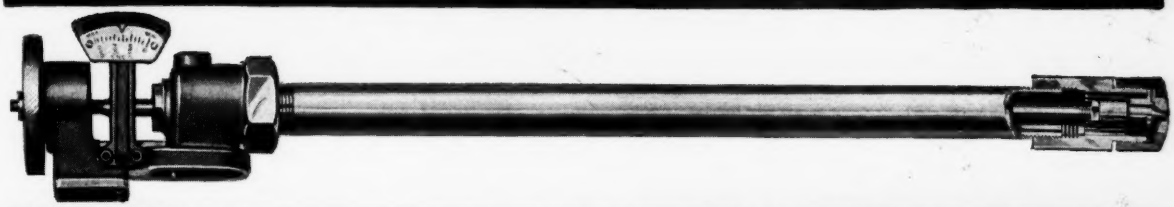
CONTROL — Manual, magnetic and combination starters; push button stations and components for complete control systems.

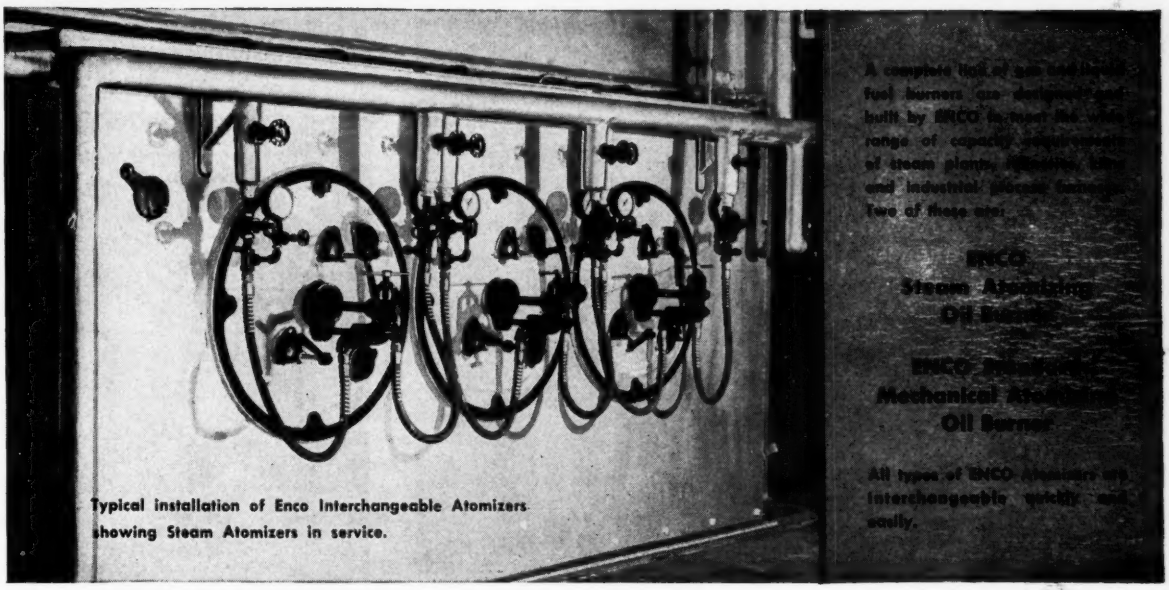
TEXROPE — Belts in all sizes and sections, standard and Vari-Pitch sheaves, speed changers.

Electrifugal, Texrope and *Vari-Pitch* are Allis-Chalmers trademarks.

ALLIS-CHALMERS

ENCO WIDE RANGE Mechanical Atomizer





Typical installation of Enco Interchangeable Atomizers showing Steam Atomizers in service.

A complete line of gas and oil fuel burners are designed and built by ENCO to meet the wide range of capacity requirements of steam plants, refineries, utility and industrial process furnaces. Two of these are:

ENCO Steam Atomizing Oil Burner

ENCO Mechanical Atomizing Oil Burner

All types of ENCO Atomizers are interchangeable quickly and easily.

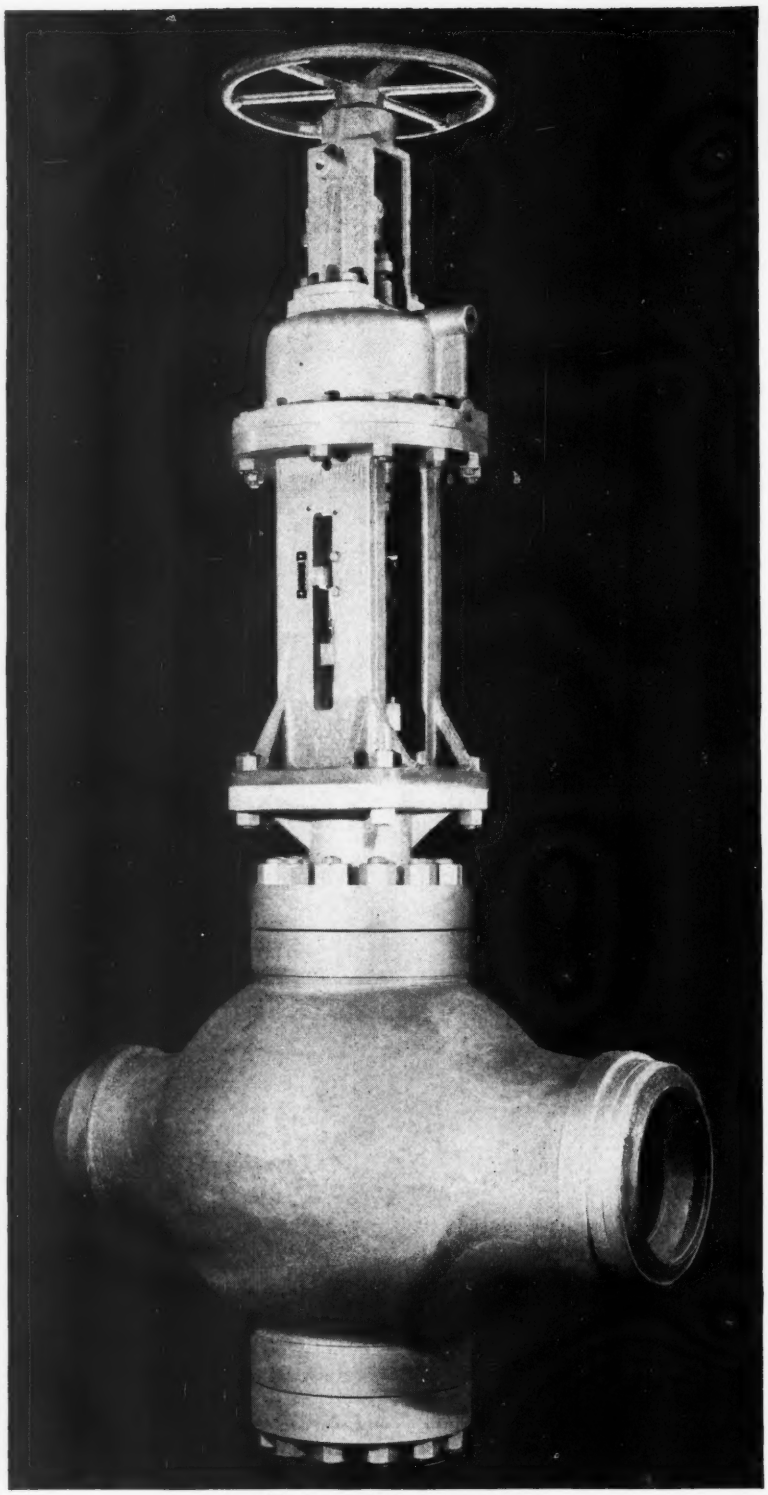
Designed to minimize operating troubles in either full load or ignition service, the Enco wide range mechanical atomizer will handle a capacity of 10 to 1 . . . without changing burner tips when using 300 psi oil pressure. This equals the performance of *five* ordinary atomizers.

Now used in many power plants throughout the country, the Enco wide range mechanical atomizer maintains a more constant velocity of oil through the atomizer, and utilizes the high oil pressure to insure efficient atomization over the entire load range. Large or small boilers can be brought on the line and carried up to full load operation without changing sprayer plates.

The Enco wide range mechanical atomizer can be controlled manually by a simple twist of the hand-wheel or automatically by a remote control or combustion control system. It is built to give most economical, efficient service for any type of pulverized coal, gas, or oil-burning register as well as for stoker-fired and industrial type furnaces.

● WRITE TODAY FOR FULL INFORMATION

EC-477

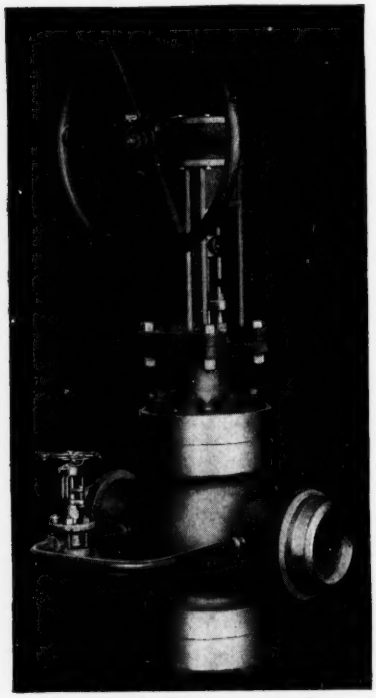


Republic 12 in. cylinder operated valve

REPUBLIC

GENERAL SPECIFICATIONS

- Built in all pressure standards—both flanged and welded ends.
- Streamlined flow through parts virtually eliminates erosion.
- Single seated valves—guaranteed drop tight.
- Double seated valves—guaranteed maximum leakage less than ½ %.
- Steam valves have heat treated stainless steel trim with screwed in seats.
- Water valves have welded in seat rings with hard surface overlay—on small valves overlay is made directly on body.
- All valves are engineered to the job or application.



Republic 6 in. hand operated valve

REPUBLIC FLOW METERS CO.

VALVES REPUBLIC

Regulating—Pressure Reducing—Shutoff

CYLINDER OPERATED—double seated

Republic cylinder operated valves are of the gradual opening, high lift, double seated type. They are hydraulicly operated to assure smooth performance at any speed regardless of size, stattic pressure or pressure reduction. These valves are available in sizes from 3" to 24", with or without hand operating wheel. Due to compact design, a regulator may be mounted directly on the valve.

HAND OPERATED—large sizes

Republic hand operated valves, in sizes from 3" to 8", are built to 900 lb. and 1500 lb. pressure standards. They are of the single seated type, have a one piece valve stem, and seat rings that are Stellite surfaced and welded in place. The gear reduction head is built with ball or roller bearings and precision ground gears for minimum friction and back lash. These valves are recommended for flow control and shutoff applications.

HAND OPERATED—small sizes

Republic single seated hand operated valves are also available in 1", 1½" and 2" sizes, built to 600 lb., 900 lb. and 1500 lb. pressure standards. These valves also have a one piece valve stem, and a Stellite surfaced seat integral with the valve body.

LEVER OPERATED—large sizes

Republic double seated lever operated valves are ideal for air actuation with long stroke cylinders. They are available in sizes from 3" to 16" for low pressure applications and in sizes up to 6" for 1500 lb. applications. The lever mechanism, of sturdy construction capable of taking full strains of power cylinders, is adjustable with full cylinder stroke to change valve capacity.

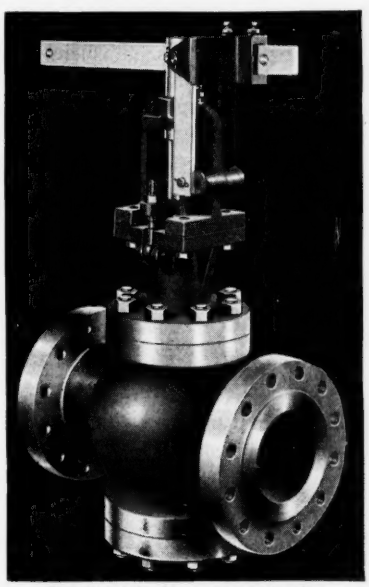
LEVER OPERATED—small sizes

Republic single seated lever operated valves are available in sizes up to 2" and for pressures up to 1500 lb. standard. The valve seat is Stellite surfaced and integral with the valve body. The sturdy lever mechanism is adjustable for lift. Many of these valves are in operation on water lines with over 1000 lbs. pressure reduction

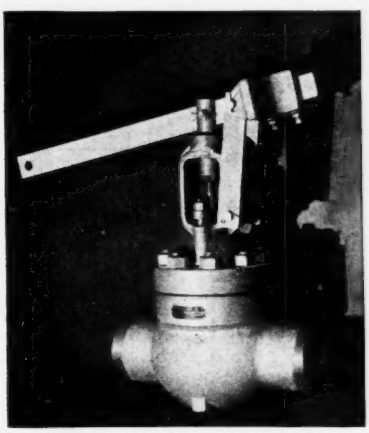
BUTTERFLY VALVES

Republic butterfly valves can be supplied in cast iron or steel for pressures up to 300 lbs. Vanes can be supplied of the angle seating or swing through types. The shaft can be mounted on ball or plain bearings as required. A valve operator may be mounted directly on valves of 6" size and over.

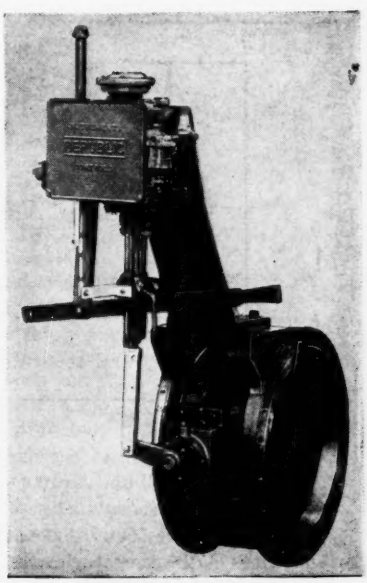
All Republic valves are engineered to the specific job on which they are to be used. Our engineers will be glad to consult with you on any of your valve problems. Write, asking to have one of our engineers call.



Republic 6 in. lever operated valve



Republic 2 in. lever operated valve



Butterfly valve with operator

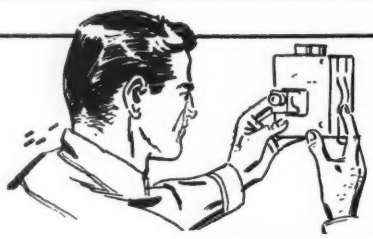
2240 Diversey Pkwy., Chicago 47, Illinois

PROCEDURES ARE Easily Followed IN HALL BOILER WATER CONDITIONING

Maintaining proper boiler water conditions is a day-to-day job, and requires the cooperation of the men in the plant. By making procedures simple, and by carefully training *your own plant personnel,* Hall Laboratories makes this maintenance a relatively simple matter.

Hall Laboratories supplies written instructions, prepared so that any man competent to operate a boiler can understand them.

You get better cooperation from men when they know not only what to do but *why* to do it. Hall engineers, therefore, explain recommendations to your plant personnel so that they understand the reasons for the procedures recommended.



Hall Laboratories has continuously worked to simplify the testing of boiler water. Hall engineers train your men to make these tests quickly and accurately.

Careful instruction of personnel is one reason why plants small and large, manned by trained engineers or by men who have come up through the ranks, have found it profitable to use Hall Service. Hall Laboratories, Inc., Hagan Building, Pittsburgh 30, Pa.

HALL LABORATORIES, INC.

(A Subsidiary of Hagan Corporation)

CONSULTANTS ON
INDUSTRIAL WATER TREATMENT
HALL SYSTEM OF BOILER WATER CONDITIONING
INDUSTRIAL WASTE RECOVERY AND DISPOSAL

Hall supplies forms on which control test data are reported. Review of these reports by Hall Laboratories gives assurance that the recommended procedures are being maintained.

LOOK HERE

FOR THE **RIGHT** ANSWER TO YOUR COAL STORAGE PROBLEM

This valuable, new bulletin, just off the press, shows you how to simplify the installation of modern, automatic, dependable coal storage and handling equipment ... reduce initial and operating costs.

It fully describes and illustrates a number of systems designed, built and installed by G-W for steam generating plants. Each installation is a typical example of the *right* one of the four basic types of G-W Storage Systems efficiently and economically meeting plant conditions of space, of climate, of capacity and of allowable initial cost.

Although no two coal handling problems are exactly alike, 140 years of experience have taught G-W that practically all of them fall within the four basic design patterns. G-W's thorough knowledge gained in applying this proved engineering principle to hundreds of installations can help you solve your coal storage and handling problem at low cost.

If you plan to modernize your present facilities or to install a new system, you'll find G-W Bulletin No. 300 extremely helpful ... and most profitable. Mail coupon or write for your *free* copy today!

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Please send, without cost or obligation, a copy of "Coal Handling Equipment," Bulletin No. 300.

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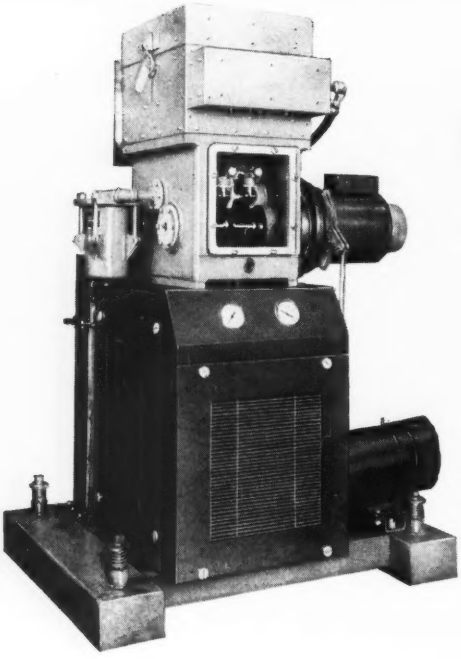


Get direct current at low voltages

- Inexpensively
- Efficiently
- Easily

with *The New*

I-T-E MECHANICAL RECTIFIER

for applications up to 10,000 Amperes, at 50 to 400 Volts D-C per unit

NOTE THESE ADVANTAGES ALSO:

- X ***Reduced size.*** A typical plant layout will show space savings of up to 50%.
- X ***Simplified maintenance.*** No complicated tools or instruments are needed for servicing the new I-T-E Mechanical Rectifier.
- X ***Low over-all cost.*** Unit assembly at factory reduces installation costs. No special structural foundations are needed.

I-T-E's new Mechanical Rectifier is the first converter ever produced in this country that can handle conversions in the low voltage ranges with efficiencies well over 95%.

This extremely high efficiency is being obtained *in actual service*. Since February 8, 1949 a unit rated at 3500 amperes, installed in the plant of the Buffalo Electro-Chemical Company, Buffalo, N. Y., has carried 5000 amperes at 260 volts d-c, with the efficiency of 96.5%.

New Operating principle: The I-T-E Mechanical Rectifier interrupts the alternating current wave at a time when the current is at absolute *zero* value. There is, therefore, no possibility of sparking or arcing at the contacts. This operation is made possible through the use of a new magnetic material — "Permeron" developed specially for use in these rectifiers.

Get the complete story: For complete technical information on the I-T-E Mechanical Rectifier, including a detailed presentation of operation principles, send for Bulletin 4809. The I-T-E Representative in your locality will be glad to advise you on adapting the I-T-E Mechanical Rectifier to your specific needs. Consult him without obligation.

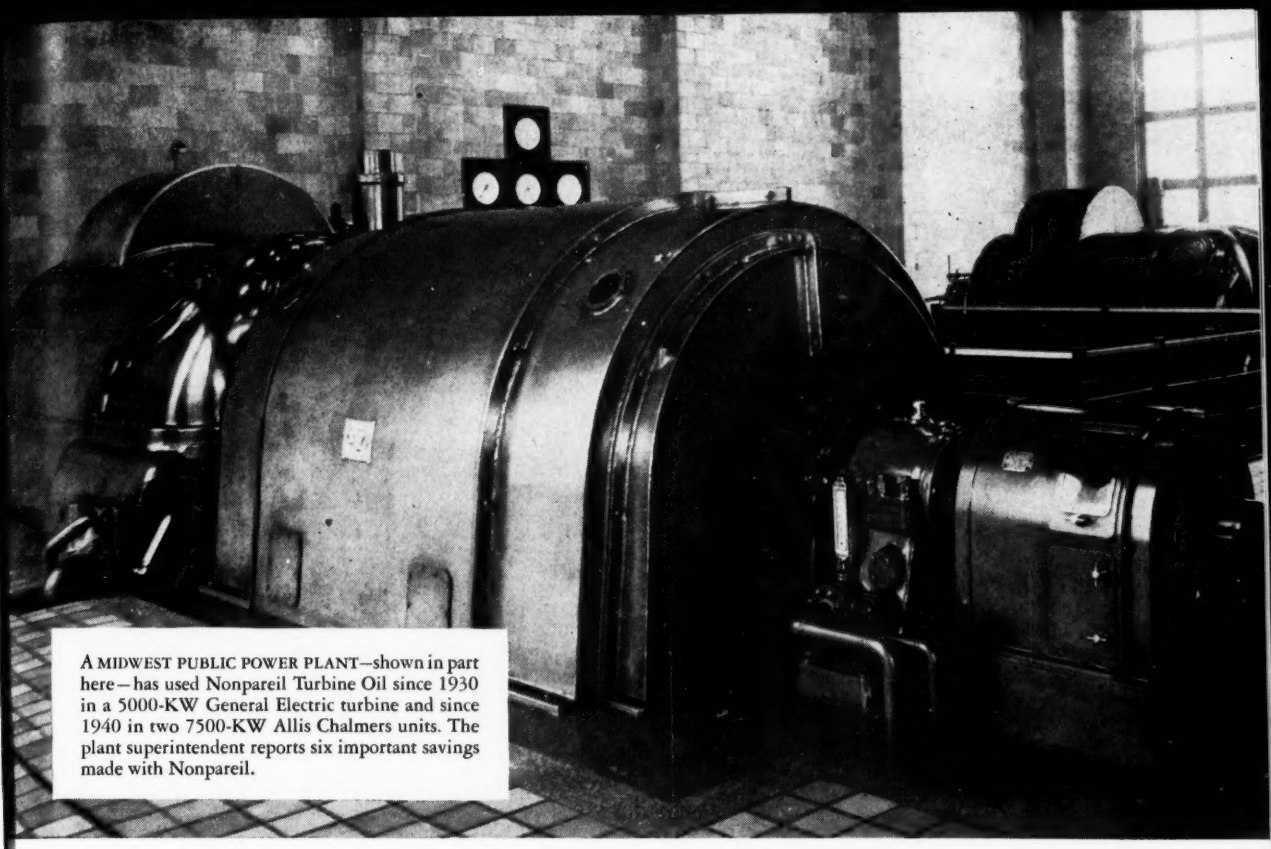
I-T-E

MECHANICAL RECTIFIERS

I-T-E CIRCUIT BREAKER COMPANY

19TH & HAMILTON STREETS, PHILADELPHIA 30, PA.

CIRCUIT BREAKERS • SWITCHGEAR • UNIT SUBSTATIONS • ISOLATED PHASE BUS STRUCTURES • MECHANICAL RECTIFIERS



A MIDWEST PUBLIC POWER PLANT—shown in part here—has used Nonpareil Turbine Oil since 1930 in a 5000-KW General Electric turbine and since 1940 in two 7500-KW Allis Chalmers units. The plant superintendent reports six important savings made with Nonpareil.

Save 6 ways on turbine lubrication

NINETEEN YEARS' service by Nonpareil Turbine Oil has given ample evidence of Nonpareil's great saving ability in a midwest public power plant. The superintendent reports:

1. No oil-replacement fills
2. No extra oil batches
3. No sweetening of oil
4. No oil-treating losses
5. No cleaning of oil systems
6. No repairs due to faulty lubrication

In addition, the superintendent states that the quantity of make-up oil has been held very low—less than an average of 12 gallons per year needed for three turbines.

Why not take advantage of Nonpareil's great saving ability? This unique turbine oil can reduce oil maintenance and lubrication troubles to a rock-bottom low in your plant. Its ability to do this is backed by a written guarantee.

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Turbine Oil

"Will outlast your turbine"

Nonpareil is the only turbine oil that is guaranteed in writing not to increase in acidity above a neutralization number of 0.15 mg. KOH/gm. That is your insurance against troubles, your assurance of lubrication savings. A Standard Oil Lubrication Engineer will be glad to give you facts and figures from other Nonpareil performance records.

Standard Oil Company (Indiana), 910 South Michigan Ave., Chicago 80, Illinois.

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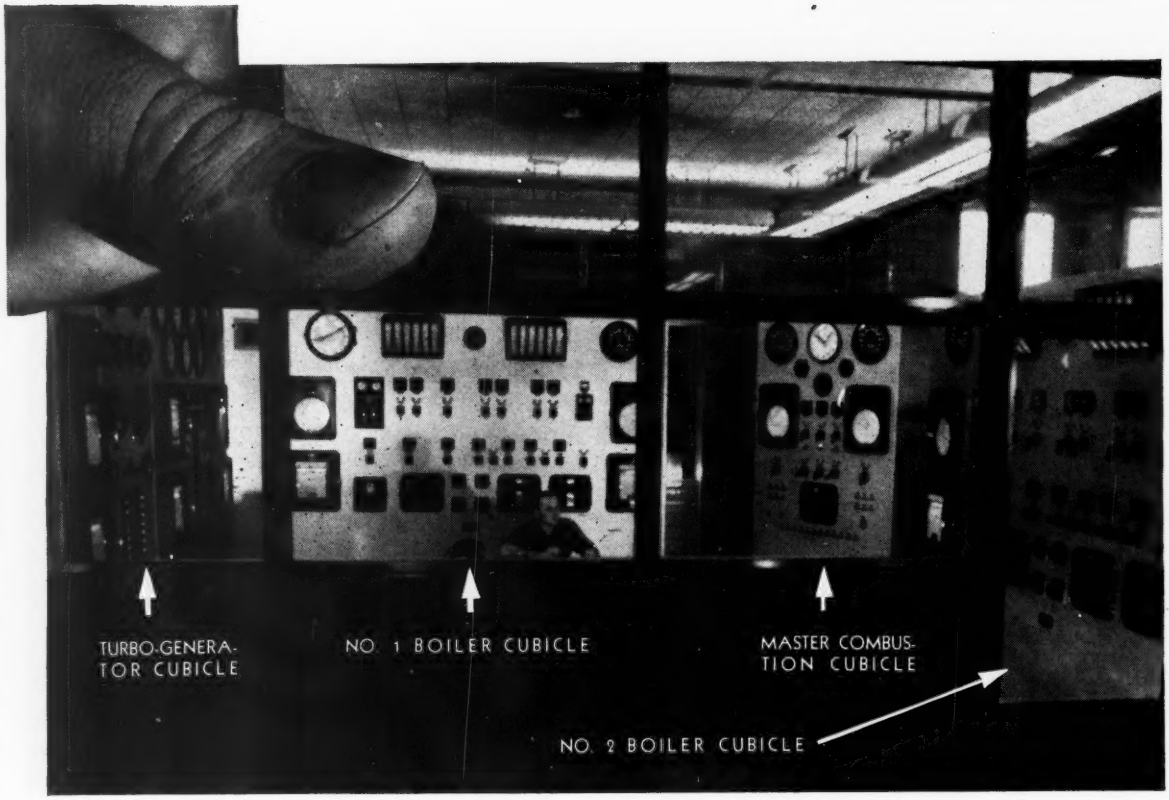

THESE L&N-BUILT CUBICLES PUT STATION OPERATION "UNDER ONE THUMB"

Control-wise, the outstanding feature of Warren Station of Pennsylvania Electric Co. is that it demonstrates the coordinated, "under one thumb" regulation of boiler, turbine and generator. A single operator, stationed in a central control room, has undivided responsibility for every step, from putting coal into the furnace at one "end" of the plant to turning out kilowatts at the other "end". Gone are telephone conversations between boiler room and electric control room operators—gone is divided responsibility.

PENELEC engineers secured the control equipment for this efficient operation in a highly efficient way. They turned over the whole job of designing control cubicles to Leeds & Northrup specialists. We can handle this work effectively, because we make key instruments for so many processes—Metermax Combustion Control; Micromax Superheat Control; Micromax Recorders for temperature, CO_2, conductivity and other conditions.

Drawing on our years of experience in power instrument layout, we proceeded to design PENELEC's cubicles from the ground up to meet their particular needs. Instruments and controllers, switches, stop-start stations, signals and alarms were arranged for correct sequential operation. Each cubicle was detailed on complete drawings showing steel work, internal piping and actual final wiring.

Before leaving the L&N plant, each cubicle was completely assembled and then tested as a unit. When the equipment reached Warren, every connection to every instrument, controller, switch and signal was in place. To be ready for use, the group of cubicles needed only to be set in position and connected to electric control drives, primary elements and station power supply. The user saved much time, trouble and expense for his own engineering staff, and has the advantages of an entirely factory-assembled cubicle.

We'll be glad to send information about L&N instruments, controllers, and panels or cubicles. Write to Leeds & Northrup Company, 4973 Stenton Ave., Phila. 44, Pa.

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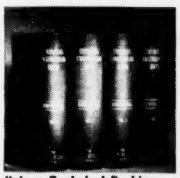

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Complete Facilities for the fabrication of steel products from simple forgings to the most intricate 120 foot towers.

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Quality Control embracing the constant application of the most advanced inspection methods, both visual and non-destructive.

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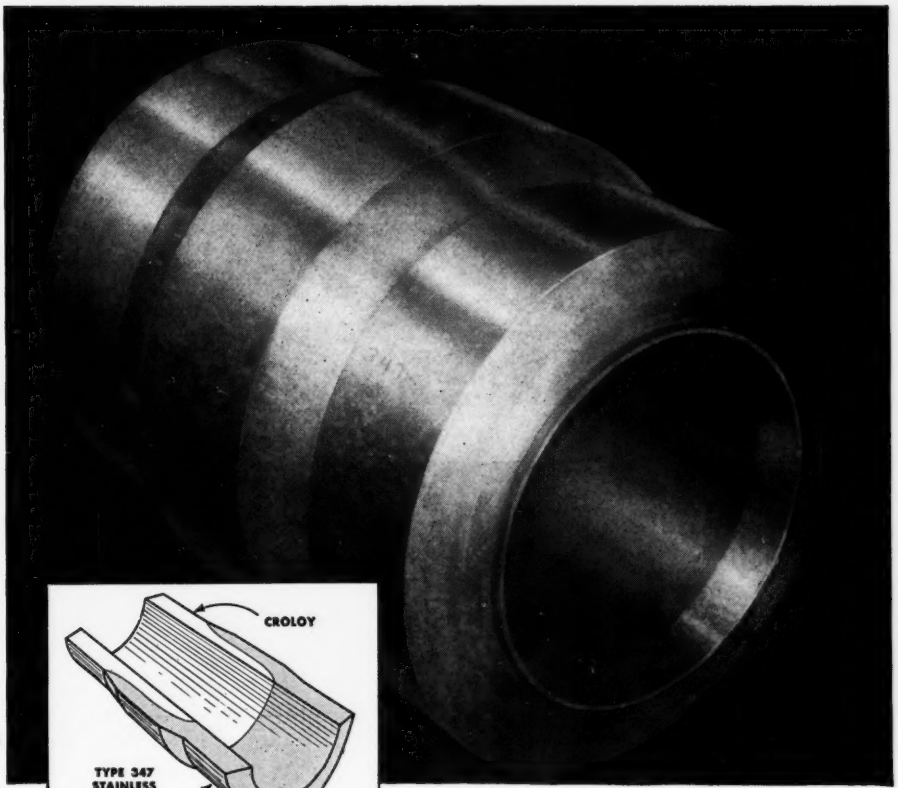

This had never been done before!

IN the first high-pressure power generating units to operate at 1050° F, just completed by the New Jersey Public Service Electric and Gas Company at Sewaren, N. J., Kellogg received the contract to fabricate and supervise installation of the main steam piping. This high operating temperature posed many perplexing problems.

But the most unusual problem concerned something that *had never even been attempted before* under such high temperature conditions. This is the story.

Boiler leads were 3% chrome-1% moly steel. The turbine throttle valves were Type 347 stainless steel. They had to be connected. However, engineers felt that welding these two diverse metals together might prove a weak point in the system because of the great difference in their coefficients of expansion.

Kellogg studied the problem and came up with the suggestion of creating *a completely new type of transition piece,* one end of which would be chrome-moly and the other stainless steel so that similar metals would be welded together. But the creation of such a piece was no simple task.

First, by their exclusive electric-ingot process, Kellogg cast the stainless steel section integrally on a chrome-moly forging. A special alloying technique was employed in the casting process which resulted in a gradual transition in analysis from one metal to the other. The piece—pure chrome-moly at one end and pure stainless at the other—was then machined to the correct inside diameter and outside dimensions.

Although a dramatic one, this is just another example of Kellogg's unusual accomplishments in the field of high temperature piping. Every day brings to light some instance where the metallurgical knowledge and unmatched facilities of Kellogg contribute to the successful solution of some new problem—producing an ordinary piece of equipment in a slightly better form or evolving an entirely new and more efficient way of performing some unusual task.

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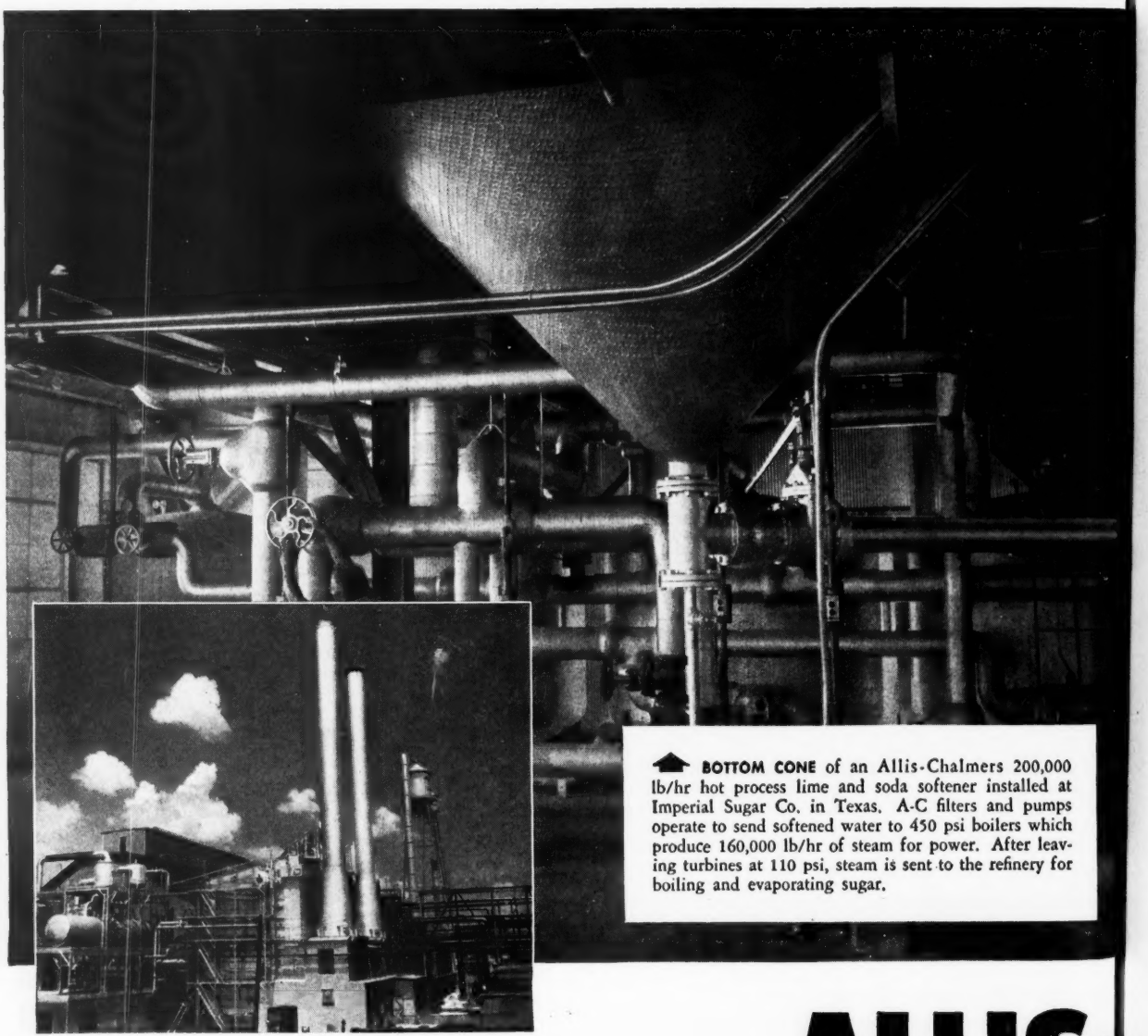
3-way program water treatment



BOTTOM CONE of an Allis-Chalmers 200,000 lb/hr hot process lime and soda softener installed at Imperial Sugar Co. in Texas. A-C filters and pumps operate to send softened water to 450 psi boilers which produce 160,000 lb/hr of steam for power. After leaving turbines at 110 psi, steam is sent to the refinery for boiling and evaporating sugar.

CLEAN STEAM for sugar processing leaves the new power plant for the Southwest's leading sugar refinery, helping to produce 1,600,000 lb of refined sugar per day.

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Water Conditioning

(SERVICE • CHEMICALS • EQUIPMENT) *at Work in Industry*

helps you solve problems!

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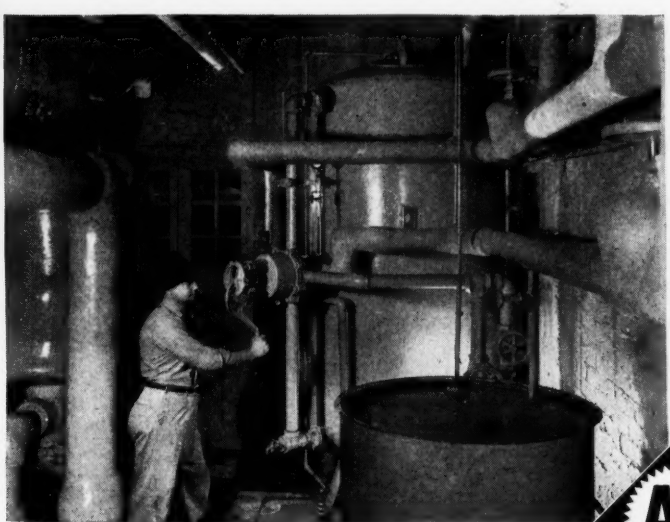
PLANT MEN IN FOOD-PRODUCING industries like sugar refining and dairying, for example, know the need for action when water treating problems arise. They know, too, that to work with a competent water conditioning organization means a savings in time and effort for all concerned.

For *all* industries, Allis-Chalmers in the water conditioning field not only provides a first hand study of water treating needs, but works right along with customer engineers in selecting the right process and correct equipment.

ALLIS-CHALMERS SERVICE starts with a complete study of water supplies and impurities, surveys of present methods and plant operating conditions. Following this: recommendations, selection of chemicals, periodic reports, and service calls.

CHEMICALS comprise a complete new line of formulations for scale and corrosion control in all types of cooling towers and heat exchangers. Also reliable AKON and SILIMITE which effectively prevent boiler scale and corrosion . . . reduce silica.

EQUIPMENT includes hot and cold process softeners, sodium and hydrogen zeolite softeners, degasifiers, deionizers, chemical proportioners, and oil removal and water filters.



SODIUM ZEOLITE softener at Pabst Farms Dairy in Wisconsin is a 9,000 gal unit treating extremely hard well water for steam-pasteurizing and evaporating fresh milk.

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- ☐ 7107 Sodium Zeolite Softeners

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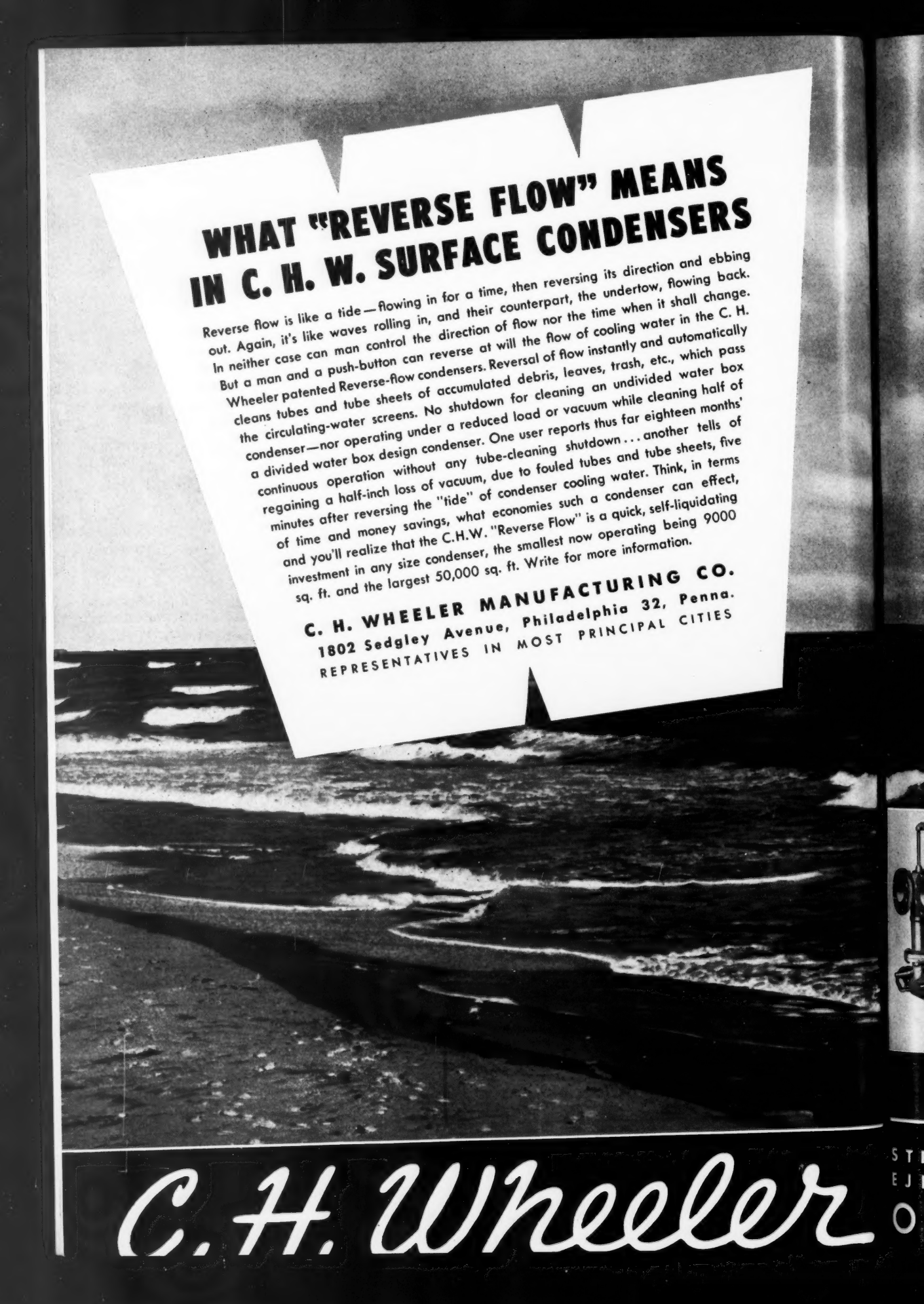

WHAT "REVERSE FLOW" MEANS IN C. H. W. SURFACE CONDENSERS

Reverse flow is like a tide—flowing in for a time, then reversing its direction and ebbing out. Again, it's like waves rolling in, and their counterpart, the undertow, flowing back. In neither case can man control the direction of flow nor the time when it shall change. But a man and a push-button can reverse at will the flow of cooling water in the C. H. Wheeler patented Reverse-flow condensers. Reversal of flow instantly and automatically cleans tubes and tube sheets of accumulated debris, leaves, trash, etc., which pass the circulating-water screens. No shutdown for cleaning an undivided water box condenser—nor operating under a reduced load or vacuum while cleaning half of a divided water box design condenser. One user reports thus far eighteen months' continuous operation without any tube-cleaning shutdown . . . another tells of regaining a half-inch loss of vacuum, due to fouled tubes and tube sheets, five minutes after reversing the "tide" of condenser cooling water. Think, in terms of time and money savings, what economies such a condenser can effect, and you'll realize that the C.H.W. "Reverse Flow" is a quick, self-liquidating investment in any size condenser, the smallest now operating being 9000 sq. ft. and the largest 50,000 sq. ft. Write for more information.

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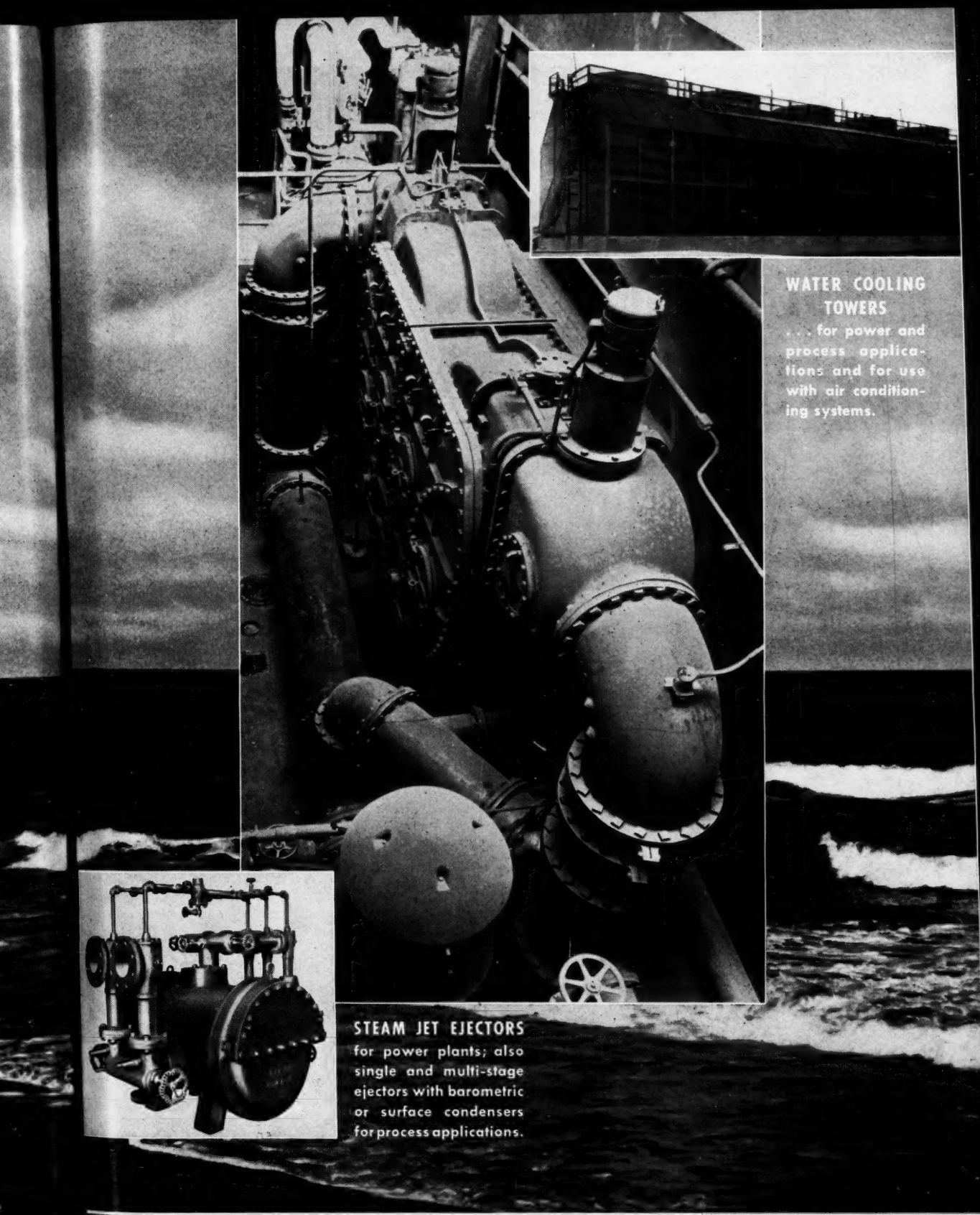

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for power plants; also single and multi-stage ejectors with barometric or surface condensers for process applications.

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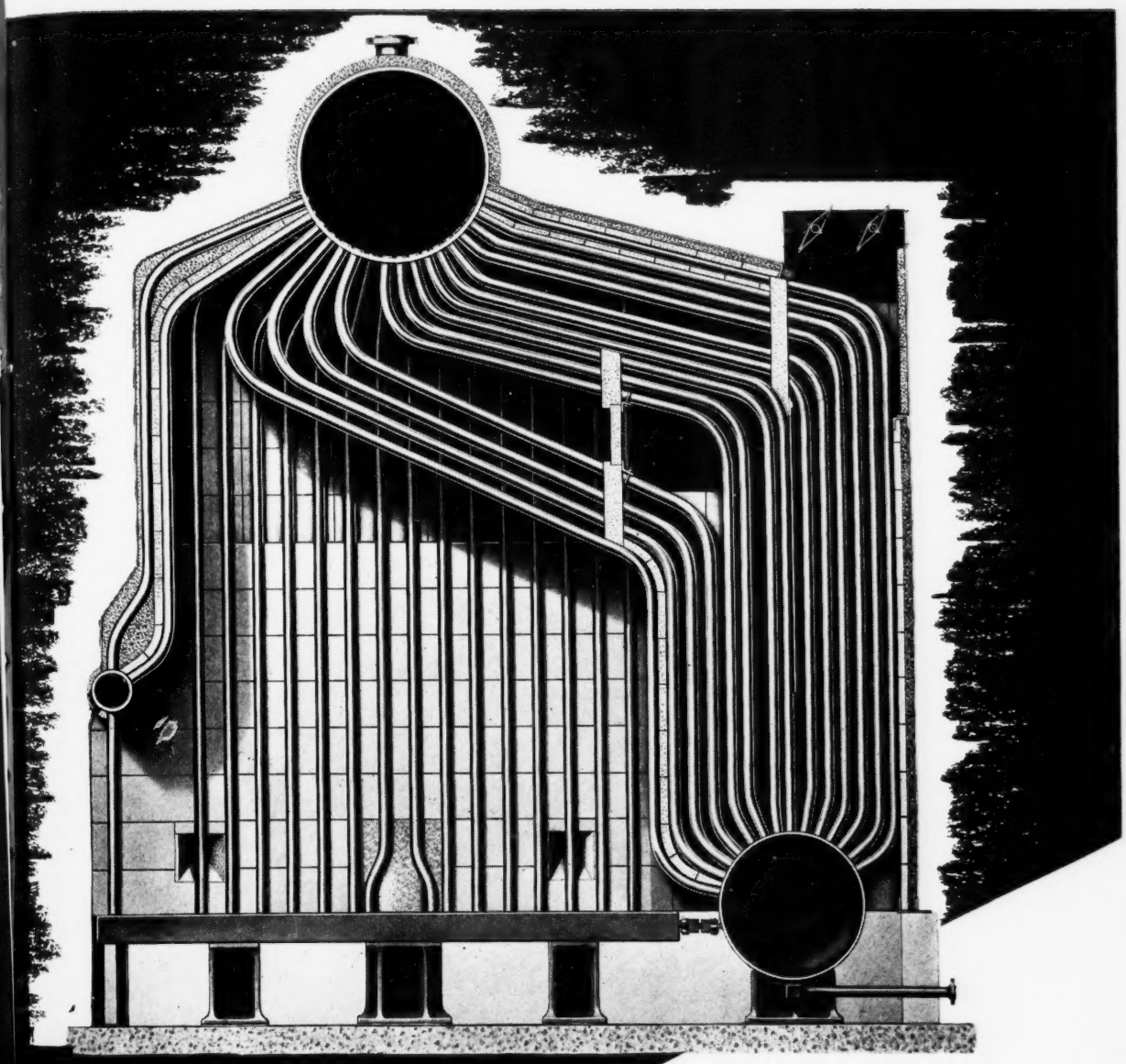

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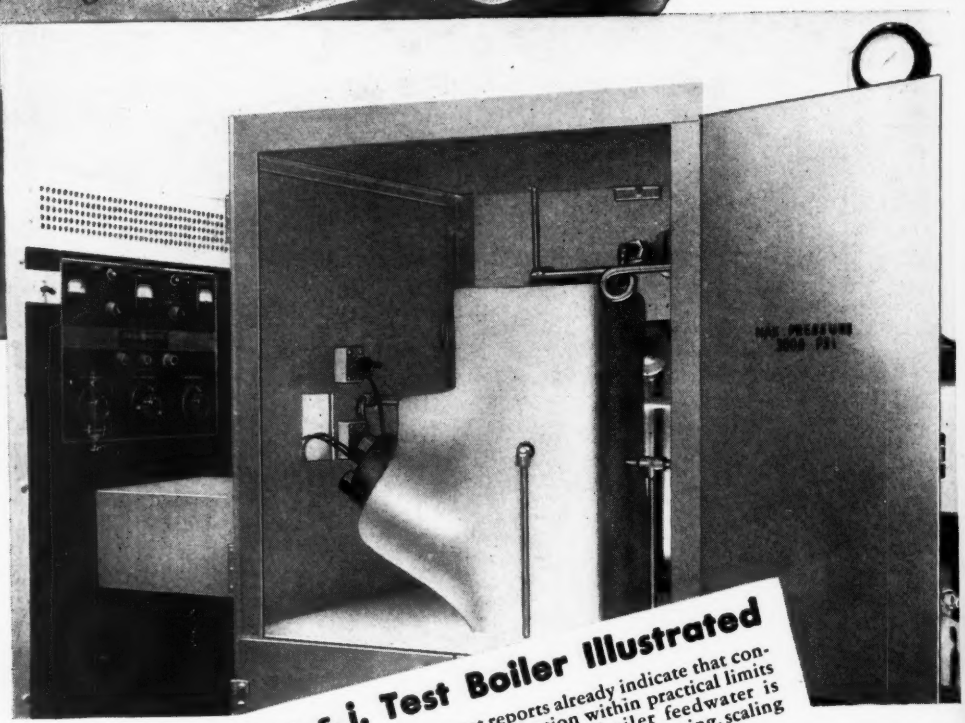

Data on 3,000 p.s.i. Test Boiler Illustrated

- Maximum operating pressure 3,000 p.s.i.
- Electronically heated by 15 KW, 540 KC induction coil, adjustable to produce varying heat transfer rates.
- Estimated maximum heat transfer rate per square foot of heating surface: 250,000 B.t.u. per hour. (Heat transfer rates in [illegible] of 200,000 B.t.u. per square foot [illegible] at 3,000 p.s.i.)
- Present reports already indicate that continuous operation within practical limits is possible when boiler feedwater is Nalco treated to prevent foaming, scaling and corrosion.
- Automatic controls, essentially the same as those on modern steam generators.
- Feedwater pre-heated and deaerated; steam condensed and returned to hot well.

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HELPFUL BULLETINS

Answers to many operating and maintenance problems will be found in these new bulletins and catalogs. List paragraph numbers of those you want on coupon below, detach and mail

ELECTRICAL

101 **Electrical Insulating Materials**—An excellent manual as well as catalog, this 36-pp publication describes Fiberglas and Fiberglas-base materials available for the insulation of wire, cable and electrical equipment of all types. Illustrated with photos, charts and tables covering types of materials and properties. One section provides comparative test data, and a list of sources of these materials is included. Textile Products Div., Owens-Corning Fiberglas Corp.

102 **Enclosed Switches**—A newly developed type of front operated enclosed switch, according to Brochure TEC-1, 4 pp, is presented as having distinct advantages aimed toward ease of installation, maintenance and improved safety. All features of these switches have been tested and approved by Underwriters' Laboratories for a-c or d-c use, the bulletin states. Back cover provides information on capacities and ratings of the switches, applications and a catalog listing of their characteristics. The Trumbull Electric Mfg. Co.

103 **Answer Card**—Rules of thumb for answering three questions concerning capacitors and for applying power-factor-improvement are printed on a double card small enough to fit in a power engineer's wallet. With this card he can quickly compute the answers to the questions: How many kilovars? What power factor? How much voltage rise? Simplified diagrams illustrate the formula for quick computation of the answers to these questions. Apparatus Dept., General Electric Co.

104 **Motors for Paper Mills**—**EM Synchronizer 26**, 16-pp. features a line of protected type large a-c motors particularly suited for use as drives in pulp and paper mills. Catalog discusses factors in the selection of motors for these and similar applications. It contains photos of several available models, emphasizing the reduced maintenance, increased reliability and ventilation control afforded by their protective enclosures. Illustrations also show many synchronous and induction motors in use. A special section of the book is devoted to an illustrated story of paper manufacturing and includes a glossary of paper terms. Electric Machinery Mfg. Co.

105 **Mechanical Rectifiers**—Presenting mechanical rectifiers as a simple solution to the problem of low voltage power conversion, Bulletin 4809, 12 pp, covers their history and advantages, using charts and graphs as evidence of their inherent high efficiency. Also provides an illustrated explanation of rectifiers' operating principles. I-T-E Circuit Breaker Co.

106 **Gear Motors**—Twelve-pp Book 1815-A, replacing manufacturer's previous catalogs on the subject, describes and illustrates double and triple reduction units of a new design in which the motor is mounted concentrically in line with the output shaft. Dimensions are shown for gear motors having open drip-proof, splash-proof, totally enclosed and explosion-proof motor enclosures. A single selection table provides for easy and accurate determination of size required. Book also lists minimum sprocket wheel diameters and contains table of maximum permissible overhung loads. Diagrams and arrangement numbers for right- and left-hand, floor, ceiling and wall mountings are provided. Price list included. Link-Belt Co.

107 **Variable Speed Drive**—**Bulletin 611-D**, 16 pp, features an a-c motor, described as having infinitely adjustable speed. Text illustrates and discusses in detail the motor and its parts, including performance curves. Also contains many photos of this drive in use with presses, extruders, mixers. The Louis Allis Co.

PUMPS, COMPRESSORS AND ACCESSORIES

108 **Industrial Pumps**—Four main types covering 26 basic series of self-priming centrifugal pumps are described and illustrated in Bulletin IB49, 12 pp. It opens with a comparison of different kinds of centrifugal pumps and a check list for selection guidance. Types described are long coupled, close coupled, vertical and belt driven, all electric motor powered and featuring free-flow design and "diffuser" method of priming. In this method automatic priming is accomplished by the design of the pump itself, the bulletin states, and clear water, coolants, chemical solutions, "dry" aromatic fluids, volatile liquids and those containing abrasives are included in the range of liquids with viscosities up to 500 ssu which can be handled. Also outlined are manufacturer's self-driven self-primers and plunger pumps. There's also a section on industrial pump installation, with tables for determining friction loss in pipe and fittings and for obtaining maximum practical dynamic suction lifts. Marlow Pumps.

109 **Centrifugal Pump Care**—Sixteen-pp Bulletin 08X6256A is a revised handbook on the care of all makes of centrifugal pumps, giving the how and why of pump construction and their effect on pump maintenance. This informative booklet tells how to figure head and it carries tables to help determine friction loss. Causes and cures for various sources of troubles are offered along with a new maintenance timetable. Also included are little known facts about cavitation and how to protect pumps against it, water's role as a pump lubricant, and common mistakes in packing stuffing boxes. Allis-Chalmers Mfg. Co.

110 **Centrifugal Compressors**—This 8-pp bulletin covers a comprehensive line of multi-stage units designed specifically for high pressure and large temperature differential duty. It discusses advantages of these compressors and the construction details which contribute to good performance. Illustrations include photos of assembly and parts, sectional drawings. Dimensions included. Clark Bros. Co., Inc.

111 **Steam Jet Air Ejectors**—This 4-pp illustrated bulletin discusses steam jet air ejectors for efficient low cost air removal from condensers. Text covers operation, types of steam jets, condensers, accessories and materials of construction. Also provides engineering data for determining required capacity of a steam jet air ejector. Condenser Service & Engineering Co., Inc.

112 **Intake Filters**—Manufacturer's line of intake filters of the "dry" type for combustion engines and compressors are described and illustrated in 8-pp Bulletin SIF. It covers standard, silencer and ground level installation models in medium and large capacities, small capacity filters and breather filters. Gives complete data on specifications, sizes, weights and capacities. Dollinger Corp.

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HEATERS

113 **Water Heaters**—Illustrated 6-pp Bulletin 70, Section 1, on instantaneous type water heaters contains detailed capacity and dimension tables for two-pass, four-pass and six-pass designs, with tube bundles removable for inspection. A typical piping hook-up for installation of these heaters is shown. Also included are instructions for heater selection, engineering data to determine boiler capacities required for heating water, and a chart to determine pipe sizes for any steam flow at most operating pressures. Davis Engineering Corp.

114 **Direct Fired Air Heaters**—Six-pp Bulletin 600, described as the most ornate published on the subject of direct fired air heaters, is illustrated with flow charts in full color, cross-section drawings, typical applications and operating data provided to simplify the definition and understanding of these heaters and clarify their applications. The appearance of this bulletin is considered timely because power engineers in practically every industry are facing the need for utilizing closely controlled high-temperature atmospheres. Peabody Engineering Corp.

TREATING SYSTEMS

115 **Chemical Feed Systems**—Single, complete "packaged" units for feeding directly into boiler feed water lines are the subject of 4-pp Bulletin 4811. It discusses in detail sodium sulfite feeding, internal treatment, chemical feeding, manual control, intermittent feeding of internal treating chemicals; automatic feed systems; automatic pH control, and automatic control by conductivity. Illustrations include photos and diagrams of controlled volume pumps and a typical packaged installation. Milton Roy Co.

116 **Water Treating Method**—Bulletin 1825, 28 pp, is a comprehensive story about a modern concept in water treating. From the story-telling full-color cover to the bibliography this bulletin tells of the development of manufacturer's water treating plant, explains its principle, distinguishing characteristics, advantages, design considerations, operation, and applications. Includes flow diagrams for typical installations, specifications and installation photos. Infilco Inc.

INSTRUMENTS AND CONTROLS

117 **Electric Control Devices**—Eight-pp Bulletin 100,000 covers manufacturer's complete line of electric control devices for industrial applications. It describes and illustrates rheostats, resistors, relays, motor starters, contractors, control accessories and dimmers. Ward Leonard Electric Co.

118 **Indicating Gages**—This 4-pp brochure, describing and illustrating the manufacturer's line of superbronze noncorrosive indicating gages, covers the types, ranges, construction details and recent improvements in these gages. Complete specifications given. Star Brass Mfg. Co. Div., Williams & Hussey Machine Co., Inc.

119 **Purity Indicator**—An instrument for measuring and indicating electrical conductance of steam and water is described and illustrated in 6-pp Bulletin 11-23-48 RCU. It discusses problems encountered with steam and condensate purity and cites examples of how controller and alarm assembly are utilized in detecting and signalling impurities caused by carryover and condenser leakage. Includes photos of typical test apparatus, also prices. E. F. Drew & Co., Inc.

120 **Flow Meter Data**—Generously illustrated with photos and diagrams, 16-pp Bulletin 400-FI is devoted to manufacturer's Shuntflo instrument for measuring steam, air or gas flow in lines from 1 to 12 in. dia, where accurate accounting of quantity flow is desired—for showing where and how much steam is being used. Bulletin explains meter's operation, tells how it should be installed, discusses its capacities, calibration and accuracy. Gives specifications and sizes, and includes capacity tables for use with saturated steam, air, and gas. Builders-Providence, Inc.

121 **Precision Pump Control**—Pub. CS-204 describes manufacturer's wide range of controls for commercial and industrial water systems. It provides 37 pp of specialized data outlining accurate, efficient control for water systems, deep wells and small compressors, deep well pumps and large compressors, standard duty sumps and tanks, cellar drain and other light duty sumps. Contains illustrations, ratings, application data and prices on pressure float and vacuum switches; heater coils, manual and magnetic motor starters; pushbutton stations; relays; automatic alternators, and high and low water alarms. Cutler-Hammer, Inc.

122 **Liquid Level Controllers**—Both direct connected and air actuated controllers are illustrated and described in 32-pp Bulletin 48-1, along with details of their special construction features, and typical applications. Schematic drawings, diagrams and photographs are included, with capacity charts, flow characteristics, pressure-temperature rating charts and dimensions. Featured also are pressure regulating and reducing valve disc-plugs, compression lubricator, stuffing box, angle valves and other auxiliaries. Belfield Valve Div., Minneapolis-Honeywell Regulator Co.

PIPING ACCESSORIES

123 **Steel Pipe Unions**—Bulletin p-100, 4 pp, features a new Pic steel union made with polygonal ends of steel pipe coupling stock for service in the 150-lb class. Includes photos of complete union and component parts and a discussion of the six major advantages of this union. E. M. Dart Mfg. Co.

124 **Flanges for Severe Service**—This 4-pp bulletin describes and illustrates a flange specially developed for services involving severe abrasion and corrosives, and for use in suction and discharge service. Photos and sketches illustrate the flange and its parts. Bulletin also covers a flexible rubber-pipe for use with abrasive or corrosive material, as well as an acid- and corrosion-resistant duct, listing solutions this duct will handle. Goodall Rubber Co.

FIRING EQUIPMENT

125 **Coal Distributor**—Bulletin 1349, 4 pp, covers a non-segregating coal distributor for stoker installations. It discusses the problem of coal segregation and explains how the "monorate volumetric" theory applied to this distributor overcomes objectionable features of many distributors. Cross section sketches illustrate these operational advantages. Bulletin also includes photos and drawings of two installations. Richardson Scale Co.

126 **Underfeed Stokers**—Bulletin 350, 24 pp, features a single retort underfeed stoker which may be operated by electric or steam drive. It is described as a complete firing unit for burning various grades of bituminous coal with high efficiency, for boilers from 50 to 150 hp rated capacities. Generously illustrated, the bulletin explains the operation of these stokers, tells their applications and gives sizes and capacities. Also contains many installation photos and diagrams and cites savings made possible by use of these stokers. Detroit Stoker Co.

127 **Smoke Abatement System**—An overfire jet system, engineered to overcome the smoke problem and to promote higher furnace temperatures, lower costs and other advantages of increased combustion efficiency is described in detail in 4-pp Form 47-49. Explains and illustrates the operation of this system, quotes authorities on overfire air and lists available equipment. Plibrico Jointless Firebrick Co.

LUBRICANTS, LUBRICATING DEVICES

128 **Silicone Lubricants**—"Silicone Notes No. 5 on Dow Corning Silicone Greases," 4 pp, gives properties, performance data and uses of these heat stable and oxidation resistant silicone lubricants. High temperature stability is demonstrated in a table of bleed and evaporation values for the silicone greases and various high temperature petroleum greases. A variety of tests data on the silicone greases is included. Dow Corning Corp.

129 **Visual Oilers**—This 8-pp booklet features company's latest line of visual oils and contains endorsements on specific applications, complete with photographs and diagrams. Examples include gravity feed, wick feed, constant level, vibrating rod and multiple oilers. Detailed catalog information is provided on every oiler. Gits Bros. Mfg. Co.

METALS

130 **Alloy Steels**—Bulletin 449-ML, 12 pp is titled, "Alloy Steels for Ball Mill

(Continued on page 100)

AUGUST, 1949
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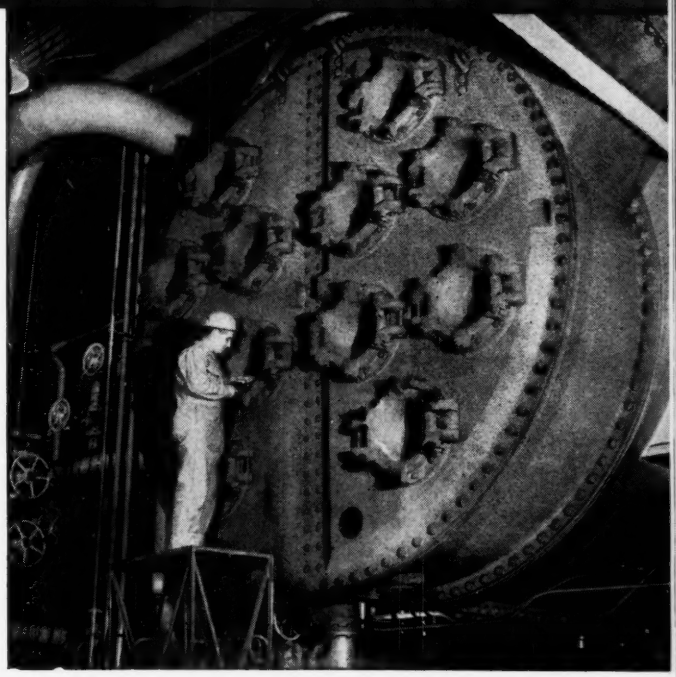

Engineers responsible for power plants in many industries know that *clean* condensers and boilers are important factors in *keeping down costs.*

To help you keep down costs and maintain designed operating efficiency in many types of heat exchange equipment, Dowell offers a fast, reliable chemical scale removal service which has been proved in thousands of successful cleaning jobs.

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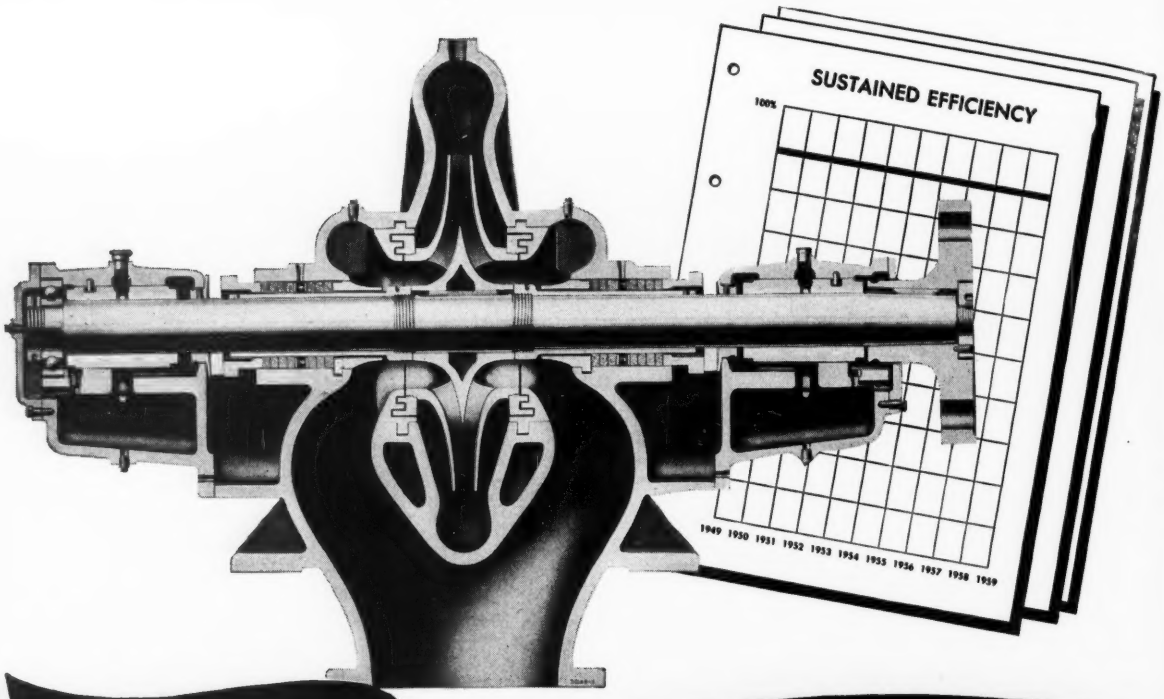

DE LAVAL
LABYRINTH RINGS

KEEP PUMP EFFICIENCY HIGH!

Here's why: Look at the diagrams at the right and you can see how the leakage from discharge to suction at the running joint is kept to an absolute minimum by the flow retarding action of the labyrinth passages.

Unlike a flat ring, the De Laval large clearance labyrinth ring does not depend upon close clearances, subject to wear and enlargement. The flow retarding action of the labyrinth keeps efficiency high for the life of the pump and you benefit by low power costs and low maintenance year after year.

When you buy a centrifugal pump, *specify De Laval*...it pays in the long run.

Send for Catalog 10-13-G

De Laval large clearance labyrinth wearing ring. Note flow retarding action of tortuous passage.

Ordinary flat wearing ring. Note that flow retarding action depends upon close clearances.

DE LAVAL STEAM TURBINE COMPANY • TRENTON 2, NEW JERSEY

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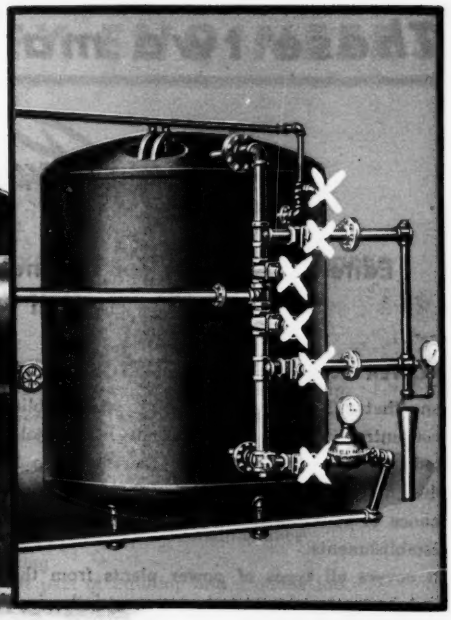
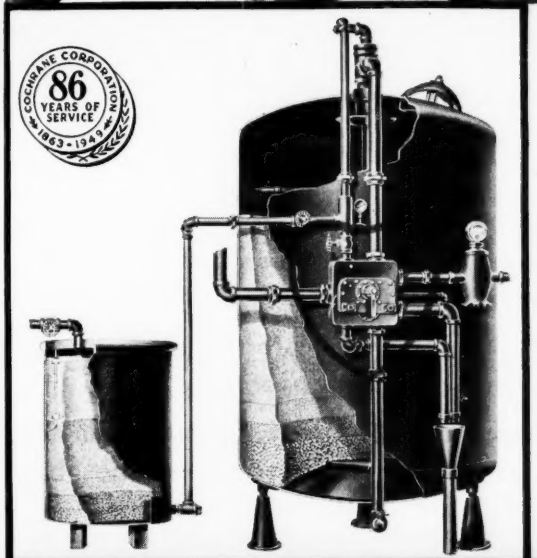
TURBINES • HELICAL GEARS • WORM GEAR SPEED REDUCERS • CENTRIFUGAL PUMPS • CENTRIFUGAL BLOWERS & COMPRESSORS • IMO OIL PUMPS

LOOK ONE HAND!



ONLY COCHRANE ZEOLITE SOFTENERS have the HYDROMATIC SINGLE CONTROL VALVE



Yes—one hand is all that is required on Cochrane Zeolite Softeners with the exclusive patented Hydromatic Valve. One hand on the control lever of one valve operates backwash, brine, rinse and service and the same lever can be used to isolate the container from service lines or drain it to bed level for inspection.

This remarkable valve is pilot operated, power being provided by the raw water itself. Valve moves smoothly from one position to the next, hydraulic shock being completely absent.

This simplification of the operator's job saves time, minimizes the possibility of faulty operation through error and saves on space requirements.

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Power Generation
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Edited exclusively for the men who Generate and Distribute Steam, Electricity and all other forms of Power Supply

POWER GENERATION'S EDITORIAL OBJECTIVE — one that differentiates it from all other publications — is to concentrate exclusively on the day-by-day job interests and long range responsibilities of the men who look after the design, construction, management, operation, and maintenance of power plants in manufacturing, utility and service establishments.

It covers all types of power plants from the large steam and hydroelectric central stations to the industrial power plant; covers not only the production of steam and electricity but also its transmission, distribution and use, as they affect the problems of the power engineer.

Adequate treatment is accorded refrigerating practice, steam and air heating, water supply and compressed air service as they come within the jurisdiction of the power engineer. The internal combustion type of prime mover represented by the Diesel engine and the gas turbine is a special but integral part of the power field, and timely articles on these units keep the reader up-to-date in regard to developments in this branch of the art.

(Such subjects are the very life-blood of power engineering but of little or no *primary* interest to plant engineers)

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Sewaren — Milepost of Progress
First complete description of this "station of the year."

Oil Systems for Industrial Turbines
A four part series. Reprinted by demand.

How to Construct Overfire Jets
Many power engineers used this idea.

Maintenance of Electronic Regulators
Taking the mystery out of electronic devices for the operator.

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Up to the minute information on a problem of increasing importance.

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A Practical Thermo-Electric Generator
A radical new proposal that might become revolutionary.

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Complete information on a new type of internal combustion engine.

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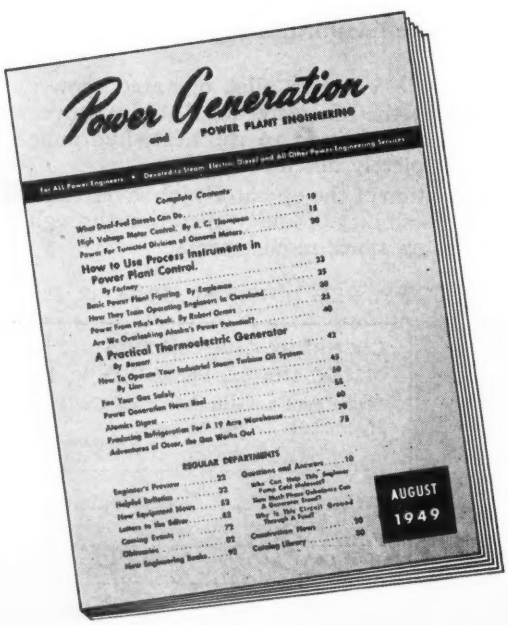
Practical solution through the high interrupting capacity fuse.

THE POWER ENGINEER'S ONLY EXCLUSIVE MAGAZINE



- Serves 24,000 power engineers—specifically and exclusively
- Interprets technical information in terms of every day plant operation
- Comprehensive, selective distribution to all men with power responsibilities by controlled circulation
- 5200 circulation gain in one year

Note: This spread is presented in the belief that readers and advertisers are interested in the basic facts which

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The only magazine edited for and distributed exclusively to men in charge of plant engineering.

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2. Illumination, natural and artificial.
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4. Air conditioning, heating, cooling, ventilation, dust and fume control, refrigeration for space cooling and process.
5. Distribution and utilization of steam, water, compressed air, other liquids and gases; piping, valves and accessories.
6. Pumps, compressors, Diesel engines and package steam generators.
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8. Construction, repair and maintenance of structures and equipment, installation of machinery; buildings and grounds maintenance.
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11. Communication, alarm and public address systems.
12. Lubrication, lubricants and industrial fuels.
13. Instrumentation, measurements and process control.
14. Planning, plant design, building layout, organization, cost and inventory control.

PLANT ENGINEERING LEADS ALL OTHER MAGAZINES in reader preference because of real editorial help.

Plexiglas in Overalls or White Tie and Tails —
94 letters received in two weeks.

Surface Treatment for Protection of Concrete Floors
Published in May. Letters still coming in.

Preventive Maintenance Programs
Articles cover many phases of maintenance

Industrial Fencing
An important part of building and grounds job.

Rats — And How To Control Them
We found hundreds of readers had rat trouble.

Selection, Use and Care of Tools
A big responsibility in every manufacturing plant.

Metallizing — New Parts from Old
Rapidly growing applications.

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A special 24 page section in January.
Many articles each year.

Industrial Lighting
Fluorescent Lamp Operation
Lighting gets a lot of attention.

Safety Articles
PLANT ENGINEERING won an award this year from National Safety Council because of the excellence of safety editorials. (It is obvious that the Plant Engineer has broad responsibilities covering all physical facilities. The Power Engineer has little or no *primary* interest in these plant engineering headaches.)

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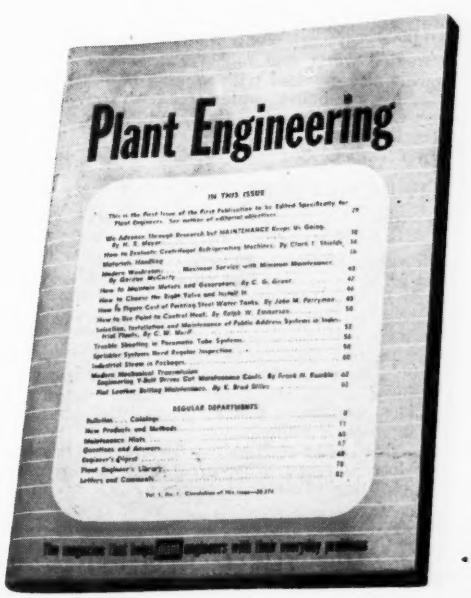

make it necessary to publish two magazines to serve these two separate divisions of engineering

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NEW EQUIPMENT NEWS

WHAT'S NEW? On these pages the Editors summarize the outstanding industrial developments of leading manufacturers who will supply you, free of charge, the bulletins or other information desired. For ease in making requests use the no-obligation, postage-paid card, pages 35-36

1—CAR SHAKER

For emptying granular materials from drop-bottom gondola cars

Weighing approximately 5 t, the new car shaker is designed to fit all sizes of gondola cars manufactured in the United States. It has an all-welded 11 by 5 by 4-ft 4-in. steel body which is lowered to rest on the car body flanges by a hoist or crane. Vibratory motion is transmitted to car through an eccentric shaft mounted within the shaker body on heavy-duty bearings. The unit is driven by a totally-enclosed, high-torque, rubber mounted motor located inside the shaker body for full protection. An enclosed Texrope drive with deep groove sheaves is used for power transmission.

The new shaker incorporates a stress-relieved body, and a minimum of working parts. It is intended for unloading coal, cinders, ore, slag, coke, sand and gravel. Allis-Chalmers Mfg. Co.

2—ANTI-FOAM TREATMENT

For correcting foaming and preventing entrainment of water in steam

Polyamide Anti-Foam Treatment No. 659, prepared in powder form, is intended for application along with anti-scale treatment for improving steam quality, controlling scale in the boiler feeding system and conditioning sludge. The compound is said to be instantaneous in action, attacking the thousands of small bubbles present in a foaming condition and reducing their number immediately.

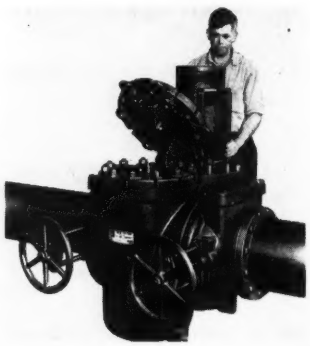
It retains its effectiveness over long periods of time, according to manufacturer, and makes possible a reduction in blowdown with subsequent savings in treated water and fuel. This treatment is also credited with making possible higher boiler water concentrations while, at the same time, reducing the solids content of the steam. Dearborn Chemical Co.

3—TWIN STRAINERS

Have two strainer chambers in one body; either can be shut off

A new line of twin strainers comes in sizes up to 24 in. for removing foreign matter from water, oil and other liquids at pressures up to 125 and 250 psi. Either strainer chamber can be shut off for removing and cleaning strainer basket without interruption of flow, it is pointed out, and because only moving parts are valve mechanisms, little maintenance is required.

Described as an outstanding feature is their low pressure drop, attributed to "straight line" flow and large basket

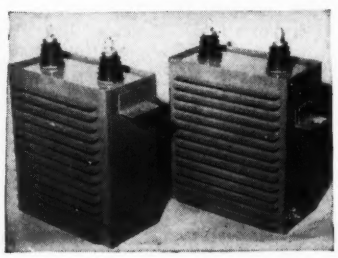


area. Strainers have cast iron Meehanite bodies with steel plate doors. Baskets are hard copper mesh on rigid frames. Electrolysis is said to be greatly minimized. Elliott Co.

4—CAPACITOR

Has 45 kvar rating housed in single air-cooled container

The PFM59 capacitor is described as the up-to-date development of manufacturer's original 15 kvar model designel in 1943 for high voltage, high frequency betatron generator applica-



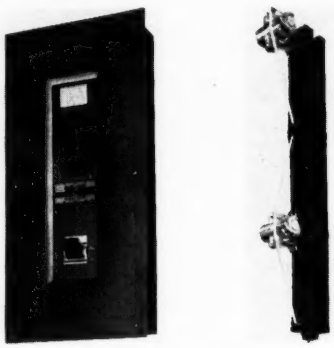
tion. It is installed in the same size housing. The new PFM59 model is being used extensively with the betatron machine for wide range research and commercial X-ray application. Cornell-Dubilier Electric Corp.

5—PANEL BOARD

In 12, 16 and 20 circuit combinations for three or four wire service

The MO Panelette is Underwriters' approved for "service entrance" applications where circuit breaker mains are required or with lugs only mains. It incorporates thermal-magnetic circuit breaker units that "plug-in" on cylindrical bus bars and are interchangeable with those of manufacturer's NMO panelboard. The "plug-in" feature is utilized to simplify changes or additions of circuits.

The Panelette boxes are only 12 in. wide and 4 in. deep, permitting surface or flush installation in shallow walls with studs on 16 in. centers. Square D Co.



6—GAGE ILLUMINATORS

Solid-wedge type, are made to show liquid level clearly

The new Solid-Wedge Type Gage illuminators are designed to give evenly diffused light over entire length of gage glass with no glare spots or blinding areas, and to enable the engineer to see liquid level easily under all conditions. Liquid level can also be read at much greater distance with this new illuminator, it is said, because the illumination from a single light source is reflected from an angular surface and flows with evenly diffused intensity through the transparent gage glass.

These illuminators are made in both explosion-proof and standard models for all sizes of transparent gages, and in both single and double section styles. Lighting is by a standard small bulb, only one bulb being necessary to illuminate two gage sections with the double section illuminator. The explosion-proof light unit is built in accordance with Underwriters' Laboratories standards for use in hazardous locations for Class 1, Group D services. Illuminators have aluminum brackets for mounting on the top two cover bolts of the gage section. Jerguson Gage & Valve Co.

7—CENTRIFUGAL PUMPS

Are self priming on suction lifts up to 25 ft; stationary or portable

A positive non-siphoning feature of these pumps is intended to assure automatic repriming regardless of the

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This **Single Source of Supply**—unequaled for completeness—can simplify every piping procedure, from design to erection and maintenance of any system. **One Responsibility** for materials helps to give you better installations, avoids needless and costly delays. **High Quality** in every item from Crane certifies to dependable performance from every part of your piping systems.

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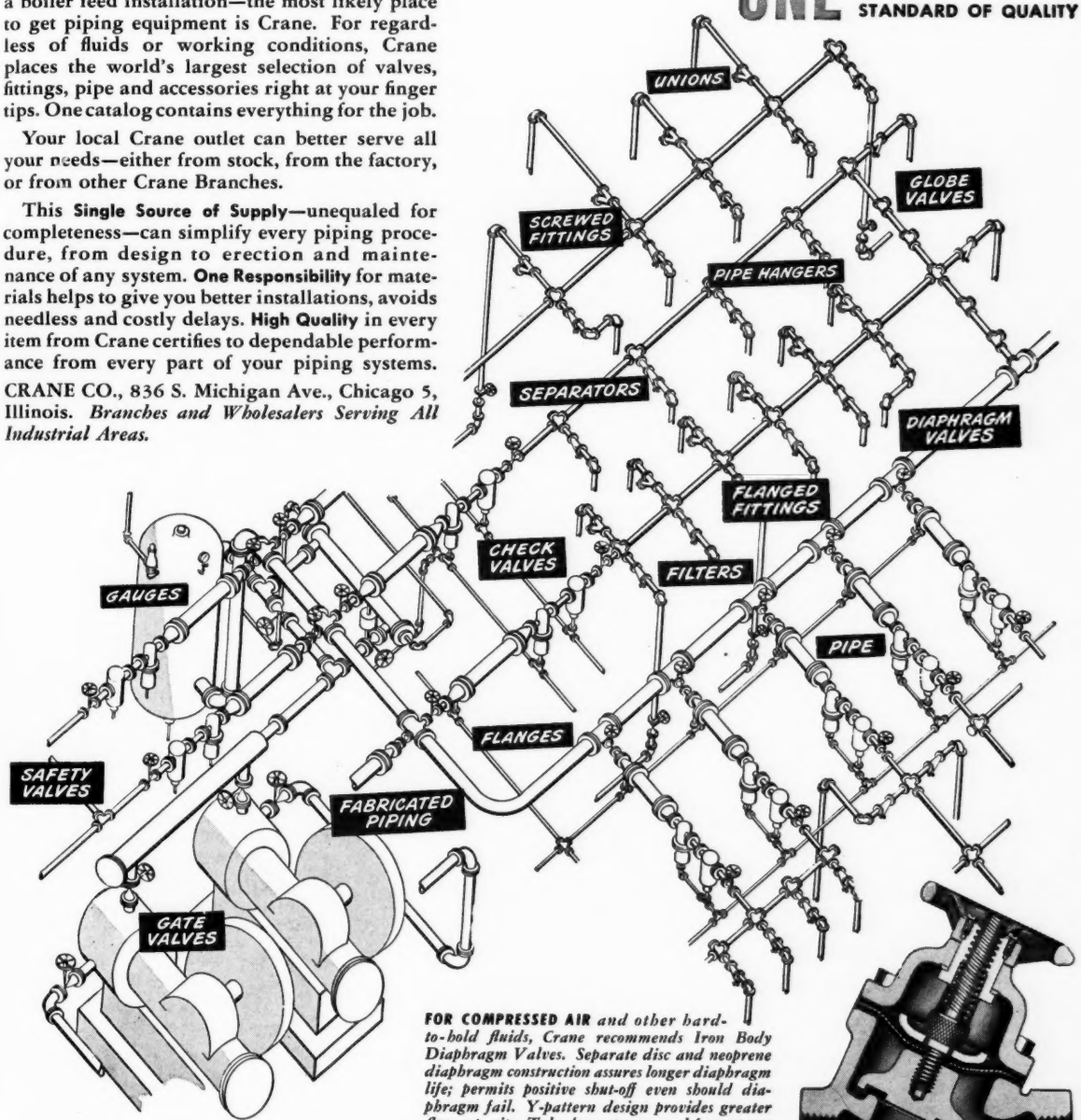

FOR COMPRESSED AIR *and other hard-to-hold fluids, Crane recommends Iron Body Diaphragm Valves. Separate disc and neoprene diaphragm construction assures longer diaphragm life; permits positive shut-off even should diaphragm fail. Y-pattern design provides greater flow capacity. Takes lower torque and fewer turns to open or close. Working pressure: 150 pounds, max.; 180 deg. F. max. Sizes: ½ to 4-inch. Write for folder AD-1761.*

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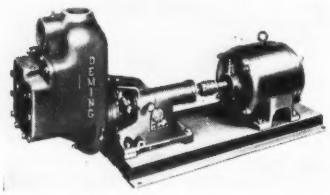
Mark the numbers of the items you wish to receive on the no obligation, no postage card. Pages 35-36.

amount of backwash or suction line surge encountered when pump stops. Six stationary models have capacities from 10 to 300 gpm against heads up to 250 ft. A portable type has capacity of 10 to 90 gpm against heads of 80 to 15 ft. Stationary types are recommended for general industrial services, mine gathering service, sump or bilge pumping. Portable type is for drainage or water handling.

Semi-enclosed, impeller permits passage of usual size solids, and is adjustable for wear. Casing is bolted to



heavy-duty support head. Shaft operates in two deep-grooved, over-sized ball bearings to resist severe use.

Certain models have casing and stuffing box separate from and bolted to support head for adapting pump to handling corrosive liquids. In this type only the liquid end parts need be made of special alloy while other parts are standard cast iron construction for economy to user.

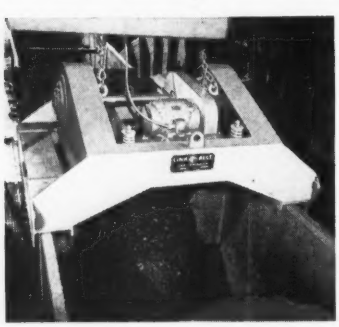
Stationary models have electric motors. Portable type has a 1½ hp, four-cycle, air-cooled gasoline engine having high tension magneto. The Deming Co.

8—CAR SHAKER

Is self-contained vibrator unit for unloading gondola cars

This car shaker is designed for rapid, economical unloading of bulk granular materials from open-top, hopper bottom gondola cars to conventional track hoppers. It is recommended for unloading coal, sand, coke, ore, gravel and cinders, and for accelerating removal of damp materials frozen in cold weather.

Cars need not be uncoupled while shaker is in operation. Rotation of shaker's vibrator shaft at normal speed causes the vibrator-end of the shaker to rise and fall and impart heavy blows



to the car and these impacts produce action where it is needed for loosening and unloading material. Usually located at the center of the car, the shaker imparts equal vibration to both ends. A feature is the low frequency of vibration for relatively quiet operation.

Normally 1 to 3 min operation of shaker is required to empty a car, and with proper spotting facilities 8 to 10 cars per hour may be unloaded. Shaker weighs 9500 lb and has a 20 hp motor wound for three-phase, 60 cycle, 220 or 440 v a-c. Its installation in a conventional car unloading shed is described as relatively simple. Link-Belt Co.

9—ROTARY PUMPS

Are designed with improved seal and bearing assembly

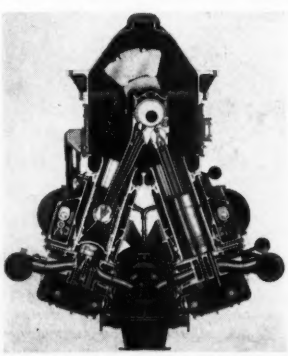
This new line of rotary pumps, designated GAMI, employ the use of a mechanical seal and self lubricating inboard sleeve bearing to carry overhung drives. Seal and bearing assembly are interchangeable on the same shaft with the standard stuffing box of manufacturer's GA type pump, so if service conditions change, substitutions of seal or stuffing-box can be made.

The seal is subject to suction pressure only, and is said to remain tight even at high vacuum. Recommended for installations requiring high vacuum and a drip-proof construction, these pumps are designed for handling liquids comparatively free from abrasive or corrosive substances, and are capable of handling a considerable amount of air or gas in the liquid. Regularly used for handling liquids of various viscosities from tar, molasses, heavy oils to light liquids such as gasoline and kerosene. Worthington Pump and Machinery Corp.

10—LARGE V-TYPE DIESEL

Is compact, 16-cylinder unit designed to develop 3,300 hp

Operating either as a conventional oil-burning Diesel gas engine or as gas-Diesel unit, the LSV engine is said to deliver more horsepower per cubic foot of space than any known compara-



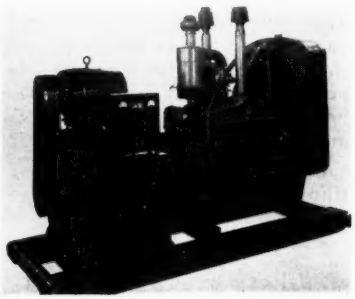
ble engine. Its compact design is said to have a direct bearing on lower cost installation because of simpler foundations and less building space required, as well as lower over-all cost of operation and maintenance.

The LSV engine is built with two banks of cylinders, 15½ in. bore and 22 in. stroke, driving a single crankshaft by articulated connecting rods. The engine, according to company engineers, is an outgrowth of their in-line type LS Diesel. Other new features include unusually low bearing pressures, motor-droven pumps, dual superchargers, low head room, larger 13½ in. dia crankshaft. The Cooper-Bessemer Corp.

11—ELECTRIC PLANT

Is packaged unit with engine direct connected to generator

The H-540 Le Roi Engine, used in this packaged electric plant is an eight-cylinder, four-cycle, operating on gas, butane, or gasoline, and is designed for maximum horse power at a minimum weight. Continuous duty rating is 30 to 50 kw, with intermittent duty rating up to 75 kw. A piston travel of 900 fpm is maintained at 1200 rpm and 1275 fpm at 1800 rpm, this low rating accomplished by the 4¼ in. stroke, it is stated.

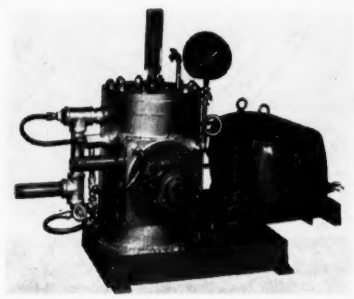


Designed for smooth operation, economical fuel consumption and low cost electricity, this power plant is supplied on a portable skid type steel base or for permanent installation. It is suitable for industrial, municipal, institutions, and other applications where independent or stand-by units are required. Carson Machine & Supply Co.

12—CONDENSATE CIRCULATORS

Are built to provide better heat transfer, lower steam costs

These High Heat Pressure Pump Circulator Units are designed to return high temperature condensate to the boiler, to maintain a maximum pressure drop between the steam inlet and condensate outlet on the processing unit, and to de-aerate this condensate before it is discharged into the boiler return line. Special features claimed for the units include jet drainage above the water level for constant



elimination of air, and the elimination of flash steam losses. Standard units have capacities of 500 to 18,000 lb of condensate per hour; special units handling up to 50,000 lb per hour may be ordered. Matco, Inc.

ARMSTRONG *"Power Plant"* STEAM TRAPS

Meet All Requirements for Modern High Pressure, High Temperature Service

ANY engineer responsible for the design or operation of modern high pressure, high temperature steam plants can safely provide the benefits of completely automatic condensate drainage by specifying Armstrong Forged Steel Steam Traps. Their inherently trouble-free design plus highest quality materials and workmanship assure safety and dependable performance. There is no chance of failure to open when condensate fills the trap and no steam loss under no-load conditions. The extensive line includes traps to meet any pressure, temperature or capacity requirements.

Armstrong Forged Steel Traps are also ideally suited to low and medium pressure service where "all-steel" installations are desired.

Where quality, safety and dependability come first, specify ARMSTRONG, the "standard" in many high pressure plants throughout the world. For more complete information and prices, consult your nearby Armstrong Representative or write:

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LIST OF MATERIALS

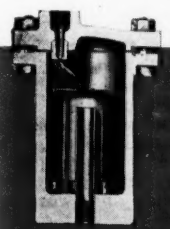
CAP AND BODY FORGINGS:
Up to 600 psi—SAE 1030 steel
600 to 900 psi—ASTM F-1 moly. steel.
900 to 2400 psi—ASTM F-3 chrome moly. steel.

VALVE AND SEAT:
Chrome steel, heat treated.

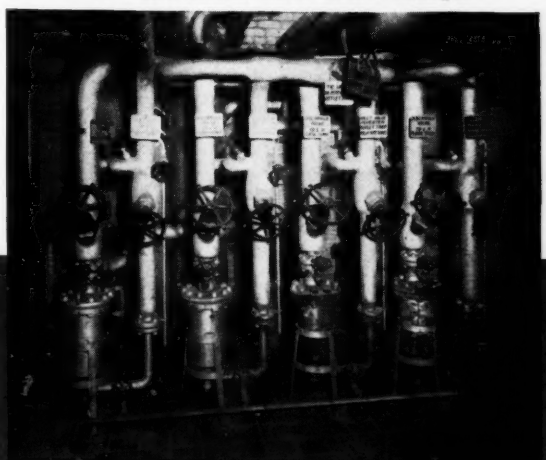
BUCKET AND VALVE LEVER ASSEMBLY:
18-8 Stainless Steel.

BOLT AND NUT SET:
Bolts supertemp steel, 149,000 lbs. tensile:
Nuts, hex, semi-finish, S.A.E. 1030.

GASKET:
Compressed graphited asbestos.



SEND FOR the 36-page ARMSTRONG STEAM TRAP BOOK for complete data on sizes, capacities, selection, installation and maintenance of Forged Steel and Cast Semi-Steel steam traps.



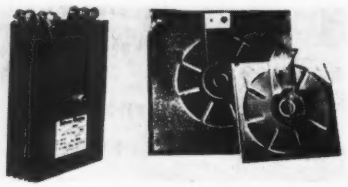
Wisconsin Electric Power Co., Port Washington Station

ARMSTRONG *Forged Steel* STEAM TRAPS

13—SELENIUM RECTIFIERS

Are dry disc type for battery charging applications

These rectifiers can be used for trickle, taper, quick, or any other type of charge, according to manufacturer, and are especially suited for unattended service since, due to the high inverse resistance, there is no possibility of battery discharging in event of power failure. They are said to be uniquely



applicable for battery charging because of relatively constant efficiency for wide load variations and their high overload capacity.

Individual selenium cell sizes range from 1¼ by 1¼ in. to 6¼ by 7¼ in. A special protective coating is applied for seashore installations or wherever salt spray, high humidity, tropical climates and corrosive fumes are encountered. Applications include electroplating, cathodic protection of underground pipe lines, d-c machine shop drive, and any other use from micro to kilowatts where d-c power is required and only a-c supply is available. International Rectifier Corp.

14—ALARM SILENCER

Is intended to eliminate manually opened alarm circuits

To eliminate the danger of forgetting to close hand opened knife switches in alarm circuits, a new Autocon Alarm Silencer, Type ABS may be used with any type electrical alarm circuit that

indicates emergency conditions such as pressure, liquid level, temperature, smoke, gas overload.

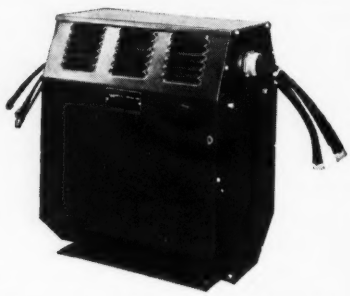
It is designed to provide continuous, complete protection even though warning sound is stopped. When emergency condition arises, the alarm is stopped by pressing button on side of case. A glowing red light remains on until trouble is corrected. When circuit is clear, the Autocon Silencer automatically resets itself and the light goes out. Construction is rugged with heavy sheet steel NEMA 1 case protecting unit from damage. Automatic Control Co.

Mark the numbers of the items you wish to receive on the no obligation, no postage card. Pages 35-36.

15—DRY TYPE TRANSFORMERS

With two rated-kva 5 per cent taps below rated primary voltage

Formerly a custom-built service on the manufacturer's regular line, the newly developed tapped units will enable users to obtain 120/240 v output from undervoltage supply lines. With ratings from 1-50 kva inclusive, the new Type

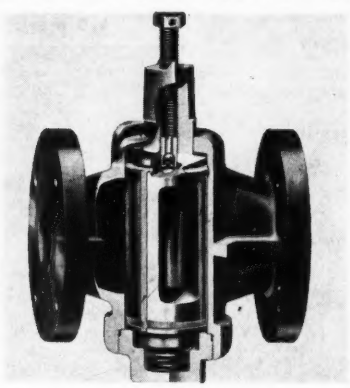


M and D transformers are designed for both 480-v and 600-v supply lines with series-multiple secondaries. They are particularly useful in lighting installations where some voltage adjustment may be necessary to maintain efficiency in light output. Specialty Transformer and Ballast Divs., General Electric Co.

16—LUBRICATED PLUG VALVE

Is designed to give longer leakless service by compensating for wear

The cylindrical plug of the Reiser Self-Seald Valve, is described as having a wedge action which not only adjusts itself for wear, but also keeps the sealing surfaces of the plug and body in intimate contact at all times to provide an extra tight seal against leakage,



and lower lubricant losses. Line fluid pressure also acts on the plug to promote the sealing effect.

Among other features claimed for the new valve are port areas equal to the area of standard pipe; a complete lubricant seal around the ports; and positive, visible stops to limit operation to a quarter-turn. Homestead Valve Mfg. Co.

17—FLEXIBLE ABRASIVE

Is developed for cleaning and polishing metals, use on commutators

Flexible Abrasive consists of a fine grain abrasive material held together

by a flexible bond and molded in stick form. It is intended to make regular commutator and slip ring maintenance easier and insure better results. When held against a turning commutator it removes high resistance film, dirt and grease. Because it is non-dusting it does not affect the face of the brush or cause filling of commutator slots according to manufacturer, and it can be used while motor or generator is in operation as it is non-conductive and non-loading.

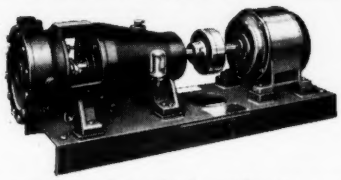
In production and machine shops, this abrasive is recommended for removing tool marks, scratches or rust, leaving a highly polished finish on copper, brass, bronze, iron, steel, aluminum and other metals.

It is said to provide the "perfect" finishing touch for commutators. It removes tool marks and produces a high polish surface for longer brush life. Made in five sizes from ⅜ by ½ by 5 in. to 1 by 4 by 5 in. Ideal Industries, Inc.

18—CRADLE MOUNTED PUMPS

Come in capacities from 5 to 450 gpm, in choice of materials

A new addition to manufacturer's line of Compacunit Pumps are these cradle



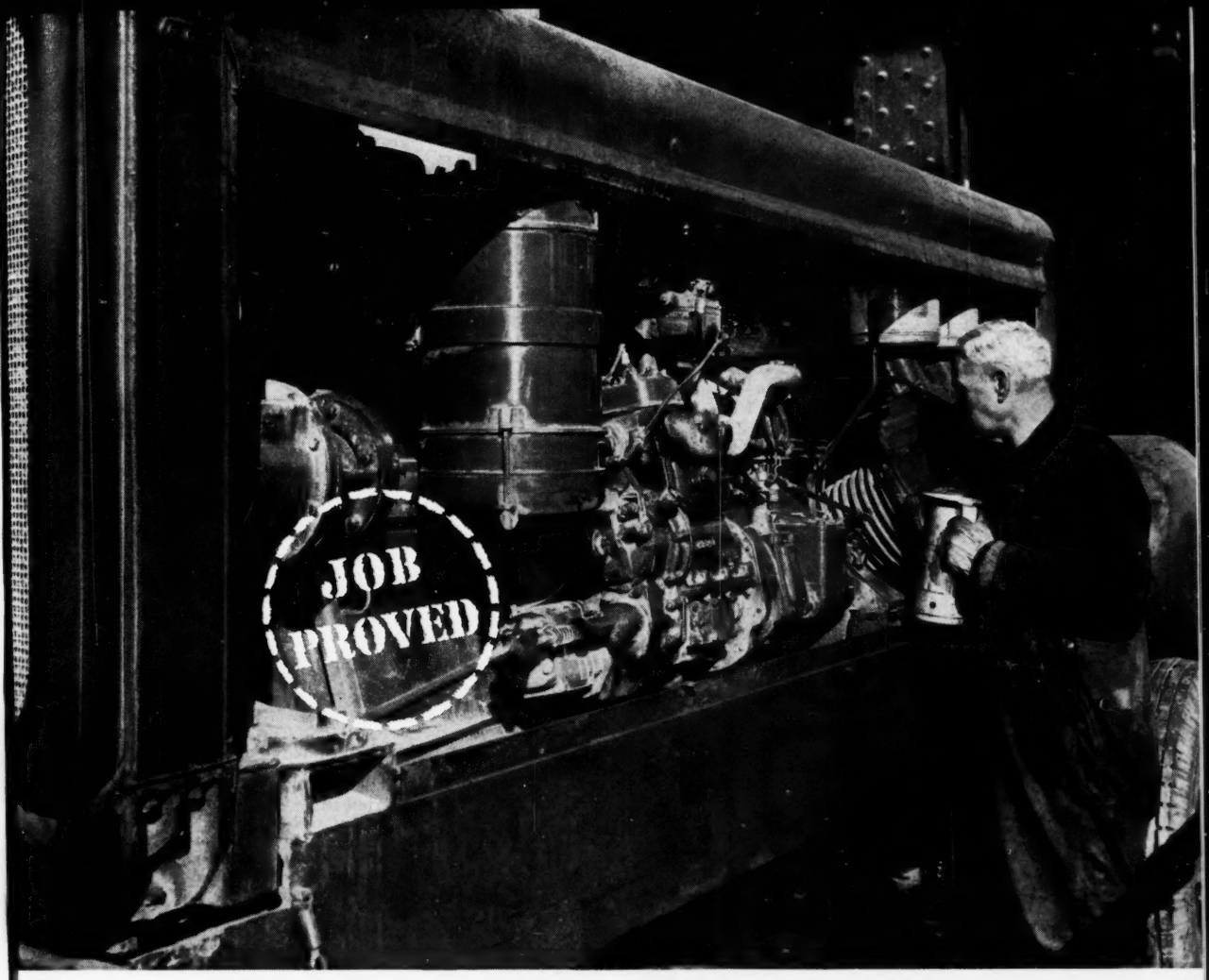
mounted models which, unlike the regular close coupled Compacunits, may be V-belt, turbine or motor driven. Available in sizes 1 in., 1½ in., 2 in. and 3 in.; capacities 5 to 450 gpm; heads 15 to 250. In standard all iron, all bronze or special metals for unusual requirements. Warren Steam Pump Co., Inc.

19—PRECISION TACHOMETER

Is designed for accurate measurement of very high speeds

This new electronic "pulse counter" is intended for special applications which call for precision measurement over a wide range of rotating speeds. The equipment consists of a high-frequency pulse generator or pick-up, an electronic counting circuit, and two speed indicating units: one for "on the spot" readings and the other for remote readings.

The first of the pulse counters measures speeds in the range of 0-17,000 rpm. In this application a magnetic pulse generator fits on the periphery of a drum attached to the shaft of the machine to be tested. The drum is magnetized, and when rotated it generates electrical impulses which are carried to the electronic circuit, and there counted at speeds up to 50,000 cycles per second. The indicators do the calculation



DIESEL MAINTENANCE CUT 50%

Sun Diesel Lubricant Eliminates Hard Carbon, Stops Sludging, Ends Costly Bearing Failures

Troubles began to pile up for a company renting out diesel-powered cranes, air compressors, and heavy-duty earth-moving equipment. Piston rings stuck with hard carbon; sludging resulted in clogged oil pump screens, bearing failures, abnormal cylinder wear. As a result there was frequent necessity for complete engine overhauls. Downtime was excessive.

A Sun Diesel Lubricant proved to be the solution to the difficulties. This "Job Proved" Product, recommended by a Sun Engineer, has been used by this concern for two years now. There have been no stuck rings, no bearing failures traceable to lubrication, no clogged oil pump screens. Cylinder wear is at a minimum. General maintenance costs have been reduced 50 percent. Efficiency is way up—to the profit of both owner and users.

Here is another example of what Sun "Job Proved" lubricants are doing to increase the life and efficiency of machinery. By helping to improve output and quality, and at the same time hold costs down, they can play a large part in making operations show a profit. It will pay you to consider how Sun "Job Proved" Products can be used to advantage by your company. Call your nearest Sun Office for complete information.

SUN OIL COMPANY • ***Philadelphia 3, Pa.***

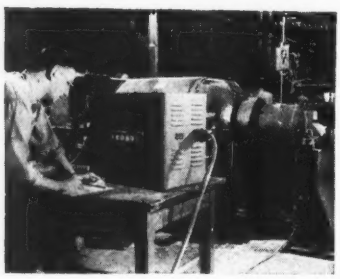
In Canada: Sun Oil Company, Ltd.
Toronto and Montreal

SUN PETROLEUM PRODUCTS
"JOB PROVED" IN EVERY INDUSTRY

SUNOCO

Mark the numbers of the items you wish to receive on the no obligation, no postage card. Pages 35-36.

and interpolation, and flash on an opal glass screen, in figures 1-in. high, the number of revolutions per minute. Continuous readings are made, the figures changing every second to indicate variations.



Up to 4000 rpm the 1500-pole side of the generator is used, with an accuracy to 0.1 rpm, while over 4000 rpm the magnetic pick-up automatically shifts to the 150-pole side and the readings are accurate to 1 rpm. Manufacturer says any system which generates electrical impulses can be used in place of the magnetic pick-up. A reading is taken every second. The counting operation requires 8/10 sec, while the calculation, interpolation, and indication of the figures utilize the remaining 2/10 sec of the cycle. The timing for this fractional split is governed by a 1,000 beat tuning fork oscillator, credited with accuracy to about 0.001 per cent.

The electronic counting circuit is housed in a 200-lb cabinet 5 by 2 by 1½ ft. The speed indicator is housed in a separate cabinet, approximately 2 by 2 by 1½ ft. The electromagnetic tachometer generator weighs about 5 lb and is approximately 6 by 8 by 4 in. Two hundred ft of cable may be used between tachometer generator and the control cabinet, and another 200 ft may be used between control cabinet and indicating units. Turbine Engineering Div., General Electric Co.

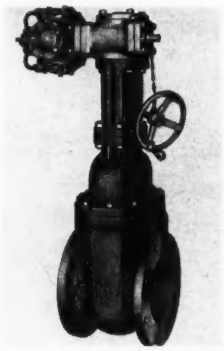
20—FLUID MOTOR OPERATOR

For gate valves, can be operated by water, oil, compressed air, gases

This simplified fluid-motor operator makes possible extensive use of motor operated valves, because the actuating unit can be adapted to stock valves or valves already installed.

The motor unit (motor, gear box and yoke), is bolted to valve bonnet; and the motor operates valve stem through gear box. The motor derives power from five flexible diaphragms, mounted radially about an eccentric on the drive shaft. Operating fluid is admitted in rotational sequence to the five diaphragms, which actuate pistons that transmit the thrust to the eccentric through a roller bearing on the shaft. By means of a suitable control, the operating fluid can be admitted through either of two entrance ports, controlling direction of operation of the motor for opening and closing the valve.

When valve gate reaches the end of its travel in either direction, the motor merely stalls, still under pressure. There can be no leakage, it is said, and shut-off devices are unnecessary. The valves can be operated by a wide range of liquids or gases at pressures from 40 to 300 psi. The operating mechanism delivers a high starting torque and is adjusted to deliver a greater torque for unseating the valve than for seating it. A handwheel is furnished for use in the event of pressure failure.



Valves equipped with fluid-motor operator are available in most types of manufacturer's iron-body gate valves in sizes 4-in. through 30-in. Larger sizes to come. The wide choice of operating fluids and pressures for powering the motor is intended to simplify installation, since available fluid pressure sources may be utilized. Crane Co.

21—HEAVY DUTY FIRE HOSE

Is developed to resist acid, acid fumes, oil and gasoline

Designed primarily for fire protection and general wash down service in acid plants and oil refineries, this high strength fire hose is also recommended for street cleaning, sewer flushing and paving operations. The hose is constructed with a natural rubber tube, two plies of chemically treated cotton cord fabric and a neoprene cover. This construction is credited with giving the hose strength to resist 400 psi test pressure and at the same time permitting greater flexibility and light weight.

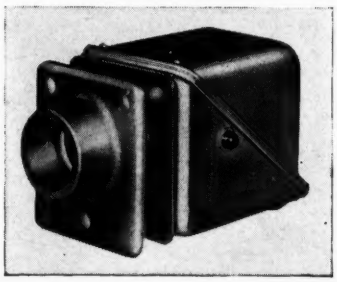
The natural rubber tube is made by an extrusion process said to make possible an extremely smooth waterway. The cotton fabric used for the plies is an adaptation of Ustex cord, widely used in the construction of heavy-duty conveyor belts. The neoprene cover is 5/64 in. thick, heavy enough to resist abuse when dragged across concrete or asphalt pavement, yet light enough to avoid bulkiness. The hose is marketed in two colors, white or black, under the trade name, Matchless Carbolized Fire Hose. United States Rubber Co.

22—PHOTOELECTRIC SAFEGUARD

Protects against flame failure of oil burning equipment

Fireye Flame Failure Safeguard Type F18T-2 gives operating flame failure protection for manually ignited oil burners, air heaters, ovens, kilns, and may be used with programming controls on automatically ignited oil burner installations. May be substituted for thermally responsive switches on existing installations, according to manufacturer, who adds that this control is approved by insurance laboratories.

It consists of a phototube and amplifying system housed in an aluminum case. Heat-resisting filters and heat insulating fins and spacers serve to thermally insulate housing from high



boiler wall temperatures so entire control may be mounted on furnace wall. Includes hermetically sealed time delay element; a pilot light indicating flame failure which can be viewed through an angle of 180 deg, and a cover switch. Specifications: supply voltage, 115/208/230 v; supply frequency, 50/60 cycles; power consumption, 10 w. Combustion Control Corp.

23—PIPE THREADS

Are designed to eliminate leakage by metal-to-metal contact

Dryseal Pipe Threads are described as accomplishing a metal-to-metal contact by a truncation of the major diameter (root) of the internal thread and a truncation of the minor diameter (root) of the external thread. Dryseal threaded pipe plugs are interchangeable with present standard Briggs type pipe thread, it is said, and plugs machined for Dryseal can be used in regular female threads with increased efficiency. Plugs threaded Dryseal are available in sizes ⅛ to 4 in. U. S. Plug & Fitting Co.

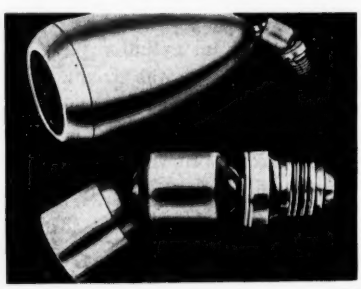
24—SWIVEL SOCKET

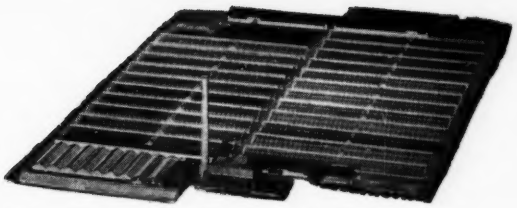
Screws into any fixed ceiling socket, adjustable in any direction

The Swivelite has double universal ball joints inside the socket to provide flexibility in a 360 deg horizontal and 180 deg vertical range. By cradling these joints under constant spring tension the unit is said to glide to any position by gentle hand placement and stay put without use of set screws or wing nuts, regardless of wear, vibration, number of adjustments or weight of bulbs.

The Swivelite accommodates any light bulb or reflector lamp with medium base. Has glazed porcelain socket, is aluminum jacketed with wiring enclosed in a twistproof construction, is said to be heatproof and foolproof. Carries Underwriters' Laboratories approval. Capacity is 660 w, 250 v.

Available as basic screw-in socket or





A TEN-ACRE Bouquet UNDER GLASS

...kept healthy at a SAVING with B&W STEAM

Typifying the cost-saving benefits of industrial boiler modernization are those produced in the greenhouse steam-plant of Frank J. Baker and Sons, Utica, N. Y., one of the nation's largest growers of orchids and fine roses.

Here, three B&W Integral-Furnace Boilers, Type FF, replaced five fire-tube units to heat 10 acres of greenhouses.

Results of the modernization are these: boilers occupy less space, allow more working area . . . are easier to keep clean and maintain . . . boiler room is now a show-place . . . operates more efficiently . . . saves fuel . . . handles rapid load swings safely.

In hundreds of other installations — from airports to zoos—the B&W Integral-Furnace Boiler, Type FF, has demonstrated its outstanding advantages of economical installation, efficient, low-cost operation and simplicity of maintenance. It will pay you to consult B&W about this design during the early stages of your plans for modernizing present facilities or for new steam plants. Would you like a copy of Bulletin G-64? Write the Babcock & Wilcox Company, 85 Liberty St., New York 6, N. Y.

Integral-Furnace Boilers, Type FF, serve over 500 other Industrial, Commercial, and Institutional Users.

BABCOCK & WILCOX

G-421

with additional 6 and 12 in. extension lengths. For supplementary lighting, this socket is equipped with hood and louverclip to accommodate spotlight, floodlight or reflector lamp in standard shapes and lengths. The louverclip streamlines the hood, serves to eliminate side spill and glare and can be used with color filters available in 17 colors. Amplex Corp.

25—FINGER U EXPANDER

In strip form, to fit most packings on hydraulic equipment

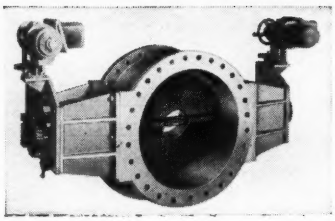
The use of a metal spring expander to exert mechanical pressure on the lip of the packing to maintain contact with the cylinder wall or plunger is considered necessary where pressure is low, or built up slowly, it is pointed out, to prevent fluid passing by the packing. The HPL U expander is produced in numerous heights of a rolled brass strip material. It is described as highly impervious to corrosion from brine solution, gasoline, alcohol, sea water and other solutions.

Extremely adaptable, it is produced in strip form, so it's necessary only to cut off the required length of expander to fit the diameter of the packing. According to manufacturer, this expander adequately and evenly supports the packing and maintains uniform pressure on both rim and inside wall of the recess by the pressure it creates on the side walls of the packing. It also is said to keep the lips of the U packing against the surface of the plunger so pressure will properly enter recess of the U and valve the lips, or sidewalls, to effect a seal. HPL Mfg. Co.

26—150-Lb DUAL VALVE

For high temperature service, is driven by electric motors

Valve No. 725, 36 by 8 in., of Class B steel, has been developed for an operating temperature of 1000 F. It is designed for either a high pressure drop and small volume or a low pressure drop and large volume, thus operating beyond limitations of a single valve. Body casting is chrome-molly steel. It is powered by separate electric motors, each alloy steel vane is operated independently of the other to insure close control of volume and pressure. Also

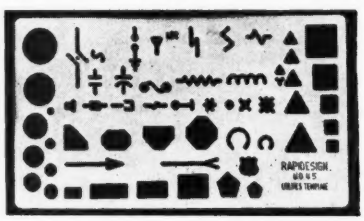


available in other materials in various combination of sizes and for higher pressures. R. S. Products Corp.

27—PUBLIC UTILITY TEMPLATE

Contains necessary electrical transmission and distribution symbols

Designed as a result of demand by public utility companies for a template specialized to electrical transmission and distribution drawing, the No. 45 contains symbols for all work from the power house to the consumer outlet,

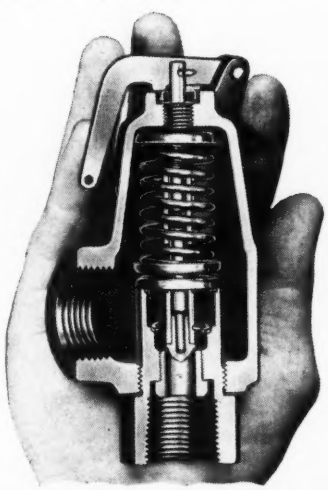


and is described as invaluable to the distribution mapper, look-up man, draftsman. Made of 0.030 cellulose nitrate mathematical stock, tinted for maximum visibility against light drawing paper, all cut-outs are precision milled. Size is 6 by 3¼ in. Price $2.50. Rapidesign, Inc.

28—RELIEF VALVE

Of large capacity, is intended for hot water heating boilers

The No. 33 Safety Relief Valve, according to manufacturer, is designed to provide a valve of large capacity, Btu rated and conforming to ASME Boiler Code at low cost. Discharge capacity —242,900 Btu per hr, certified by the National Board of Boiler and Pressure Vessel Inspectors, is said to be sufficient for more than 70 per cent of all hot water heating boilers.



Operating characteristics are described thus: When the set pressure of 30 lb is reached, the needle lifts just far enough to discharge water at the low rate necessary to take care of the thermal expansion of water. If the temperature rises into emergency zone, increased velocity acts on the hydra-lift ring, greatly increasing lifting power and snapping the valve wide open to dissipate heat at the rate of 242,900 Btu per hr.

Valve cone and seat are stainless steel. Testing lever operates independently of the automatic pressure action so it is not disturbed by opening of the valve in service. McDonnell & Miller, Inc.

29—SPREADER STOKER

For boilers up to 1000 hp, has adjustable fuel distributor

A special feature of this automatic spreader stoker is an adjustable fuel distributor capable of handling a wide range of coal sizes. Grates furnished with the stoker are designed to prevent sifting of fine coal and at the same time to provide liberal air admission in order to give low gas velocities in the furnace. Controls, especially designed for the stoker, are furnished at the customer's option. The Standard Stoker Co., Inc.

30—DRY LUBRICANT

Comes in liquid form, to be applied by brush, spray or dipping

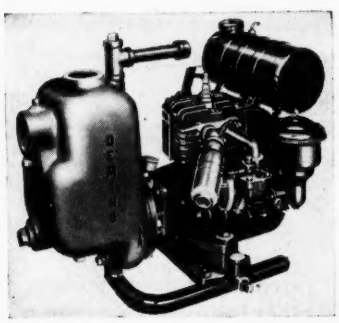
Neolube is a ready-for use, opaque black composition designed to give a dry lubricated surface. It is said to dry in seconds, leaving a dust-free adherent film of graphite. For use on meter and alarm mechanisms. Also as an electrically conductive paint for contact points, switch blades, electronic tube prongs. Costs $1.00 for 2 oz; 35c for 10c bottle. Huron Industries.

31—CENTRIFUGAL PUMP

Is portable, self-priming; for drainage and water handling jobs

Designed for a wide variety of uses where electric power or belting facilities are not available, this new centrifugal pump is equipped with a 1½ hp, four-cycle, air-cooled gasoline engine having a high tension magneto.

Pump has cast iron casing, bronze impeller mounted directly on engine shaft, and a mechanical type shaft seal. Pipe connections are 1½ in. suction and 1½ in. discharge. Dimensions are: length 20 in., width 13 in., height 19 in. Net weight 83 lb. Performance ratings range from 10 gpm with 80 ft heat to 90 gpm with 15 ft head. The Deming Co.



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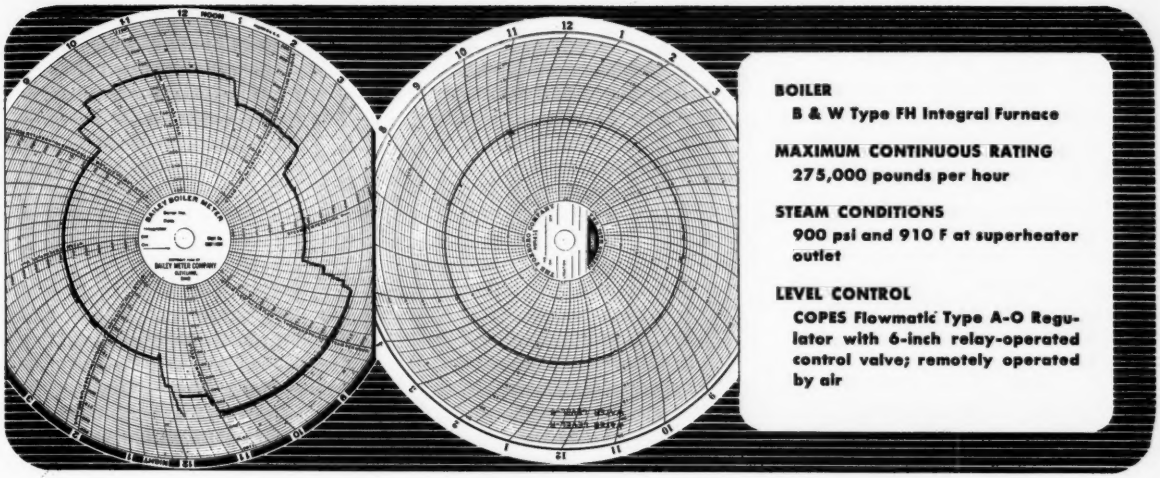


BOILER
B & W Type FH Integral Furnace

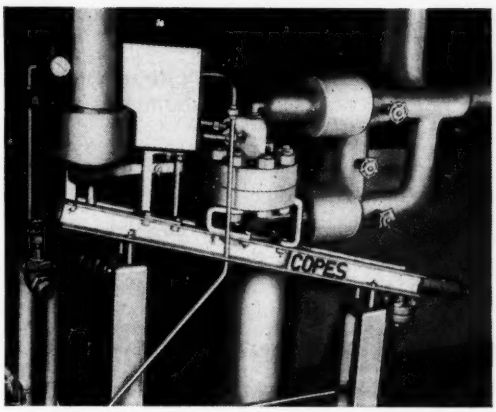
MAXIMUM CONTINUOUS RATING
275,000 pounds per hour

STEAM CONDITIONS
900 psi and 910 F at superheater outlet

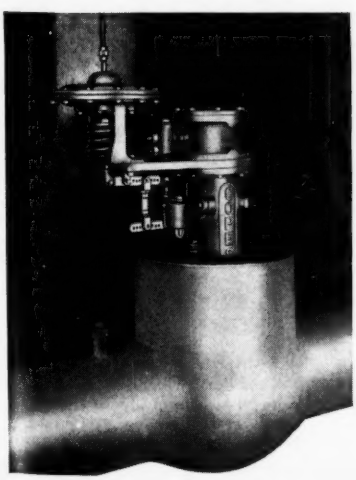
LEVEL CONTROL
COPES Flowmatic Type A-O Regulator with 6-inch relay-operated control valve; remotely operated by air

COPES FLOWMATIC TYPE A-O*

HOLDS BOILER WATER LEVEL *Plus or Minus* ½ INCH



*A-O means remote air operation, with both flow- and level-responsive elements (above) at any location with respect to the feed control valve (below). Fits any piping layout, any operating preference. Remote panel adjustment, if desired.



Maximum load recorded on the steam-flow chart was 250,000 pounds per hour; minimum, 135,000. There was a drop from 235,000 to 132,000 pounds per hour between 11:50 p.m. and 12:10 a.m., with a total level change of less than one inch. Between 8:00 and 8:08 a.m., a load increase of 50,000 pounds per hour resulted in no more than 1.2 inch total level change. During periods of constant load, water level was constant.

This precise water-level stabilization was obtained under fully-automatic COPES Flowmatic Control. The complete story is told in Performance Report 487. Write for a copy. You'll see why this utility station repeated with COPES Flowmatic—why you should depend on COPES Control in your boiler plant.

NORTHERN EQUIPMENT COMPANY
892 GROVE DRIVE, ERIE, PA.
BRANCH PLANTS in Canada, England, France, Austria and Italy. *Representatives everywhere.*

COPES

Headquarters for . . .

Boiler Feed Water Control . . . Excess or Constant Pressure Control, Steam or Water . . . Liquid Level Control . . . Balanced Valves . . . Desuperheaters . . . Boiler Steam Temperature Control . . . Hi-Low Water Alarms.

A COMPLETE SYSTEM...

FOR INSTANT, ACCURATE CHECK ON LIQUID OR BOILER WATER LEVELS THROUGHOUT THE PLANT

Yarway Remote Liquid Level Indicator with Control Unit attached.

Now you can have constant check-up on water levels wherever —and whenever—you want.

The Yarway Liquid Level Indicator, equipped with Yarway Control Unit and auxiliary electric signalling devices, provides this check at two or more locations anywhere in the plant.

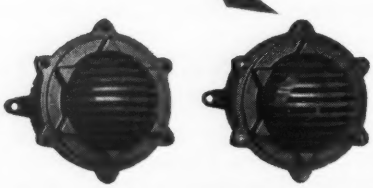
The Yarway Indicator is always accurate because it is operated by the liquid itself. Indicating mechanism is never under pressure. There are no stuffing boxes. Complete separation of indicating and actuating parts is achieved by permanent magnet transmission.

The Automatic Control Unit is attached directly to the Indicator and operates the remote signal alarms (light or horn) at any remote locations.

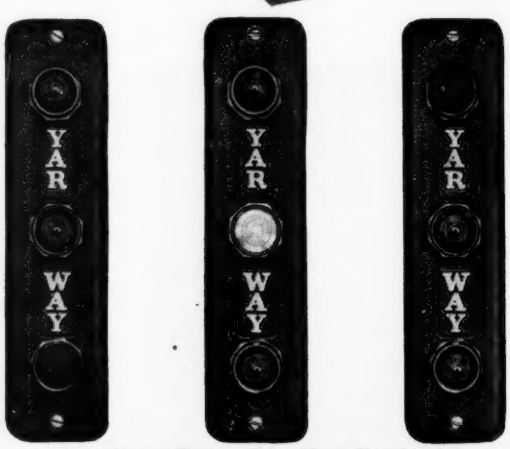
The Control Unit may also be used as a control for mechanical equipment such as motor-operated valves, pumps, etc.

FOR COMPLETE DESCRIPTION AND SPECIFICATIONS OF YARWAY REMOTE LIQUID LEVEL INDICATORS, WRITE FOR BULLETIN WG-1822.

YARNALL-WARING COMPANY
114 Mermaid Ave., Philadelphia 18, Pa.



Yarway Remote Hi-Lo-Alarm Signal Horns.



Three Yarway Remote Hi-Lo-Alarm Signal Lights, showing low level, normal operation and high level. Each unit shows all levels.

YARWAY REMOTE LIQUID LEVEL INDICATOR

LETTERS TO THE EDITORS

RECLAIMED LUBRICANTS

THE PRESENT TREND in the utilization of used and reclaimed lubricating oils as fuel oils, necessitates a more definite understanding, as well as, a word of caution. This practice has increased in the past few years, due in part to the scarcity of fuel oils during the war, and high prices. These high prices made possible, the profitable reclaiming of lubricating oils as fuel oils, when before it was not economical to do so. It is possible to use these reclaimed oils as fuels, but there are a number of difficulties involved. The intention of this letter is to illustrate some of these pitfalls, so the user or consumer, as well as the purchaser of these types of materials, may be aware and conscious of these difficulties.

In this report, by lubricating oils are meant, only mineral oils of the following types: motor, cutting, quenching, tempering, transformer, and oils similar to those here mentioned. The greatest volume of reclaimed oils are composed of crankcase drainings, or used motor oils, while the other types make up a small percentage.

There is little chemical difference between fuel oils and lubricating oils, as they are both composed mainly of carbon and hydrogen. The only difference lies in the percentage of each element. More extensive refining methods are employed in the production of lubricating oils than fuel oils, primarily because of the more precise function, the lubricating oils are called upon to perform.

There is a marked difference between the physical properties of lubricating and fuel oils. Actually lubricating oils would make better oils for combustion than fuel oils, but are too expensive and valuable. Certain specifications of lubricating oils would cause some difficulty if used exclusively for burning, such as too high a flash, and too low a viscosity when used in certain types of burners and operations. Listed are some physical tests to illustrate the difference between the various oils:

	Lubricating oil	No. 4 Fuel oil	No. 5 Fuel oil
Gravity API	24	28	16
Viscosity at 100 S.U.	250	60	700
Carbon	0.03	2.00	7.00
Flash Open Cup	350	160	250
BSW	nil	0.20	1.00
Pour Point	Plus 10	-zero	Plus 40

When used oils are picked up they are quite a mixture. Some are light, some heavy, some clean and some dirty, as their containers usually range from underground tanks to open pails. It is easy to understand the contamination that can occur when the containers are open to the atmosphere, resulting in becoming contaminated by rain, sand, mud, lint, leaves and all similar types of material. Besides the contamination from outside sources, metal grit from motors, and metal chips and trimmings from machine tools, are found in the oils. As few establishments have any facilities, as well as making no attempt to keep the oils clean, all these types of contaminates are sucked through the truck hose, and into the truck, when picked up either from gas stations, or factories.

These oils are then pumped into a large storage tank for treatment. Sometimes the only treatment is to let it settle by gravity alone. Occasionally heat is added, as it lowers the viscosity, thinning the oil and making it easier for the water and sediment to drop to the bottom of the tank. Filtering and centrifuging is also employed, but all of these methods, including heating, increase the cost, and as the margin of profit is usually quite small, no extra methods are employed, if it can be accomplished economically by settling only. The use of chemicals is also used occasionally to drop out the water. The settling time varies from 3 to 10 days, depending upon the methods of separation used, as well as the type of material to be reclaimed. In some oils, the sediment is so small in size, that it will not separate unless after a long period of settling, which runs as high as 2 to 3 months. As mentioned the method of separation of the water and sediment varies. Some methods will give a good clean reclaimed oil, while others will give only fair results. One illustration from past experience is the attempt to reclaim by gravity settling without heat, in the winter time. The lower the temperature the more viscous the oil, which holds the sediment tightly in suspension, preventing any from dropping out. After it has sufficiently separated it is pumped from storage and delivered to the consumer.

A word of caution is now necessary to the consumer. One of the principal reasons for buying reclaimed oils, is the difference in price between them and regular fuel oils. Though the price may be cheaper, so may the grade and quality of oil that is being purchased. Not all reclaimed oils are clean and free from dirt, grit, lint and water. Sometimes there is still considerable contamination in the oil, ranging from 2 to 10 per cent, and even higher. Besides buying and paying for non-combustible material there is a danger of accumulating a large deposit of sludge in the storage tank, necessitating a costly clean-out job. Another problem that may result is clogged strainers and burner tips, causing shut-downs and loss of heat and production. An item frequently overlooked is the fact that most reclaimed oils have a considerably lower viscosity, than the fuel oil usually burned, meaning greater consumption and readjustment of boiler house valves and pressures.

Most used motor oils have various degrees of gasoline dilution, which can lower the flash point of the reclaimed oil, where it may be dangerous to use, or necessary to exercise additional care in handling. The flash of a good lubricating oil may be as high as 350 to 400 F, but after use, it may be as low as 80 to 90 F, and sometimes lower than those temperatures. Some oils, such as cutting, quenching, tempering picked up from factories, are usually mixed with naphthas, and solvents, which will lower the flash point.

Where the reclaimed oil is a good grade, clean and free from light oil or gasoline dilution, the oil may have a too high flash point, causing some difficulty in starting.

Good clean reclaimed lubricating oils should have a transparent color and shining luster, and not opaque, when poured slowly from a container. Dirty oils will have a dull muddy appearance and the water and sediment can be easily seen by letting it stand in a container or beaker, for a few hours. After settling pour off the liquid and note the water drops, and the black gritty sediment on the bottom. The oil may appear to be clean, but sometimes if poured through a 100 mesh screen, fine strands of lint, as well as some large particles of sediment will be retained, which may block up burner screens and tips. According to standard fuel oil specifications the material should pass thru a 16 mesh screen, but this type is too large to retain some of the contamination, that can cause burner trouble, with certain small type burners using a very fine screen.

Lubricating oils will not mix with fuel oils satisfactorily, unless certain conditions, such as heating and agitation are employed. Without those conditions, the lubricating oil has a tendency to rise to the top, and remain only a partial mixture with the fuel oils.

Cleveland, Ohio PAUL F. SCHMIDT

(Continued on page 112)

The new Columbus, Ohio factory of the Ternstedt Division of General Motors requires huge quantities of compressed air. As described in this article, this air is supplied by 2 steam turbine-driven air compressors and 1 motor-driven unit, each with a capacity of 2731 cfm. The exhaust steam from the turbines heats the entire factory

DESIGN

Turbine-Driven Compressors Supply Air For G-M Factory

By E. J. TURNBULL and W. H. RYAN
Engineers, Power Department,
Dravo Corporation

COMPRESSED AIR SERVES as "power" for much of the production machinery used in manufacturing automobile hardware parts at the new Columbus, Ohio factory of Ternstedt Division of General Motors Corp. The huge quantities of air required are supplied by three twin-unit, water-cooled stationary air compressors, two operated by steam and one by a synchronous motor.

The power plant for this new factory was designed to achieve maximum efficiency in the use of steam that is produced by two integral furnace boilers, each having a capacity of 70,000 lb per hr of dry and saturated steam at 215 psig. Exhaust steam from the turbines operating two of the air compressors is used to heat the entire factory having a floor area of approximately 640,000 sq ft. Design and construction of the power plant were handled under a "single contract" plan by the Power Department of Dravo Corporation, Pittsburgh.

Because the factory is located near one of Columbus' residential districts, Ternstedt officials specified that the power plant be designed to operate with as little smoke and dust as possible. Fully automatic combustion controls, mechanical dust collectors, a fly ash reinjection system and dustless ash unloading equipment are among the measures incorporated in the design to meet this condition.

The powerhouse structure was literally built for cleanliness. Liberal use of masonry and tile inside and outside not only gives the building an attractive appearance but makes it easy to keep clean. Of steel frame construction with reinforced concrete foundations, the building has masonry walls with precast concrete trim and steel sash. The compressor room is partitioned from the boiler room by smooth-surfaced facing tile. Cream colored ceramic tile is used for wall surfacing in the compressor room, offices and locker room. Smooth-faced tile is installed in other areas. Red quarry tile is used for flooring in the compressor room. Fluorescent lighting is installed throughout, except in those areas where vaportight lights are required.

Each of the three twin-unit radial type air compressors has a capacity of 2731 cfm against a pressure of 110 psi. They rest on foundations which were built as separate structures and have no connection with the building framework. Dry saturated steam at 200 psig, discharging against a back pressure of 20 psig, is used for the turbines that drive two of the compressors. The turbines have double helical reduction gears and oil pressure governors that provide for a 3-to-1 speed adjustment. At full load of 516 hp with 600 rpm output speed, steam consumption is 39.3 lb per Bhp per hr. The third twin unit compressor is driven by a 4800-v synchronous motor. Operation of this compressor permits balancing compressed air requirements

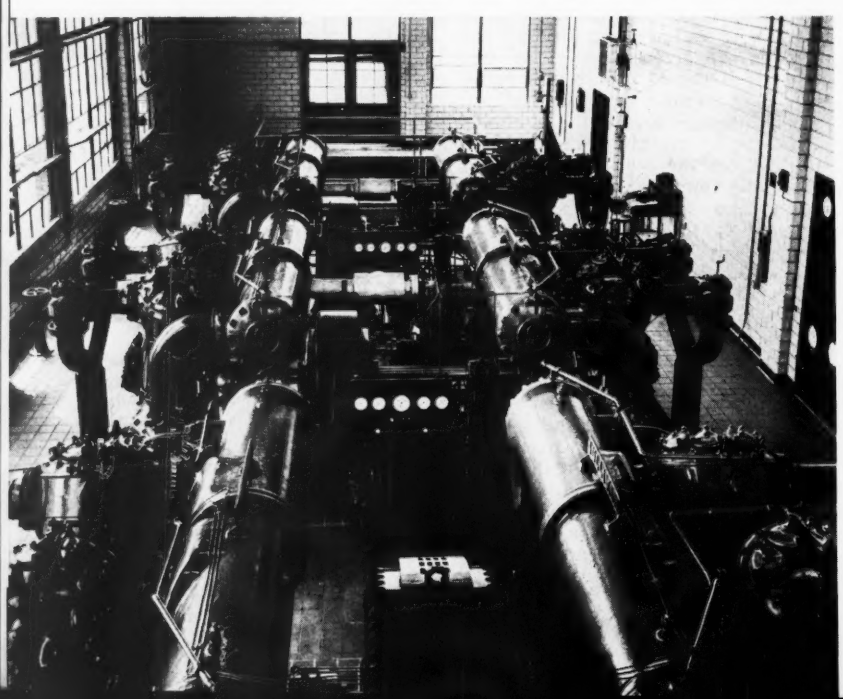


Fig. 1 The compressor room has ceramic tile wall surfacing and red quarry tile floor. It is partitioned from the boiler room. This view shows the motor-driven compressor in the foreground and the two turbine-driven units beyond

with the need for exhaust steam. The electrically-driven compressor is operated mainly during the summer months when steam requirements are at a minimum. Each twin compressor has two intake filters of the silencer type. Each also has an oversize 3700 cfm pipe line type after cooler with automatic condensate traps. The three vertical outdoor air receivers are 60-in. in diameter by 14-ft high. A 10-ton overhead travelling crane is provided in the compressor room to facilitate servicing of the air compressors.

The two boilers have sectionally supported ignition arch and curtain walls immediately above the stokers and extending up to the water wall headers. Water wall sections are backed by ship-lap tile and high temperature insulating material. Refractory sidewalls of the furnaces and boilers are of sectionally supported construction. Instead of a steel casing the entire boiler setting is finished with semi-plastic refractory troweled smooth.

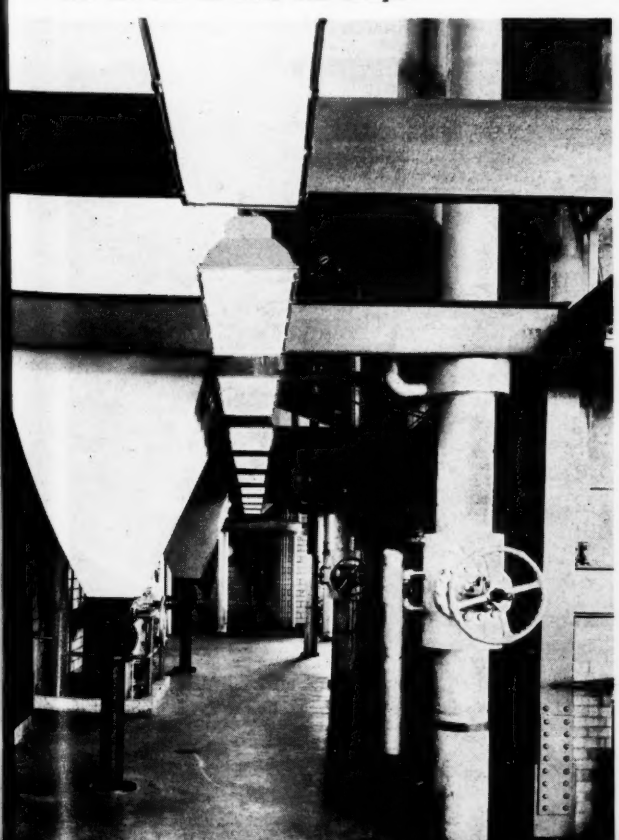
Forced draft for the boilers is supplied by two turbine-driven fans located in a plenum chamber in the basement. Combustion air is drawn into the chamber through louvered openings in the outside wall. Fly ash collected in boiler soot hoppers is reinjected into the boilers by a stream of air supplied by a separate motor-driven fan. One of the boilers has an induced draft fan arrangement that is dual driven by connection through free wheeling clutch couplings to a 70 hp steam turbine and a 75 hp, 1160 rpm electric motor. The fan has an inlet box damper arranged for operation by the combustion control system. The other boiler uses turbine drive only for the induced draft fan with turbine speed regulation by the combustion control system.

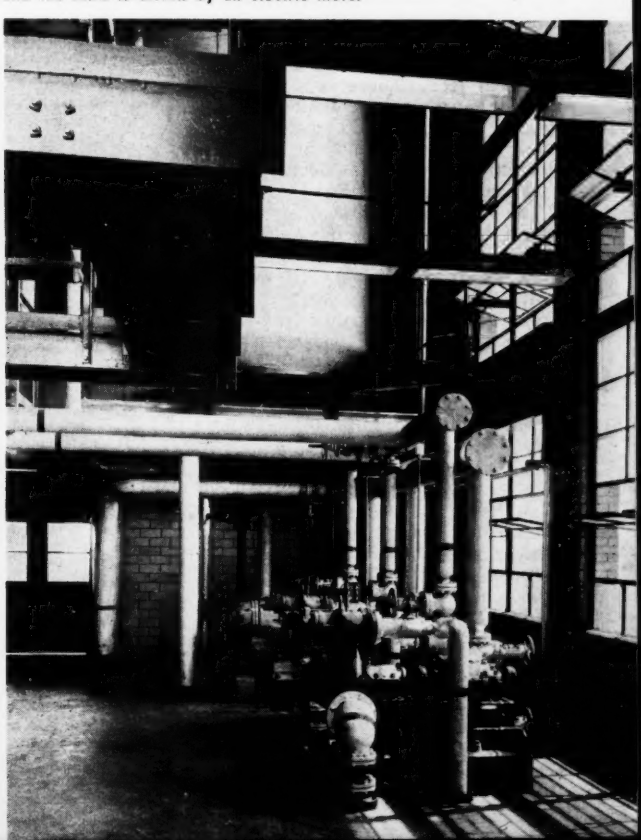
Each boiler is fired by a continuous ash discharge type rotary grate spreader stoker having three rotors designed for use with bituminous nut, pea or slack stoker coal. The stokers are motor driven and one of the units is provided with emergency steam turbine drive.

Fig. 2 (Above) This photograph shows the two 70,000 lb per hr integral furnace boilers. These are fired by continuous ash discharge type rotary grate spreader stokers having 3 rotors designed for use with bituminous nut, pea, or slack stoker coal

Fig. 3 (Below, left) Fly ash hoppers, located under the precipitators, are shown here. They feed into the ash storage bin

Fig. 4 (Below, right) Two of the main boiler feed pumps, shown here, are steam driven, and the third is driven by an electric motor





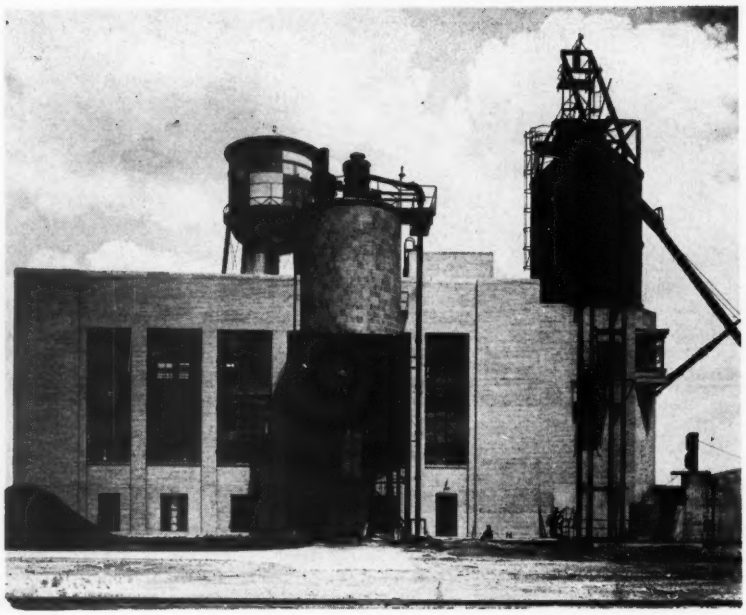


Fig. 5 Rear view of the powerhouse, showing the 70-ton ash storage hopper and dustless unloader, and coal storage bin with skip hoist. Operator of the drag scraper system for outdoor coal storage yard sits in control booth in right corner of building

List of Principal Equipment

Boilers—Babcock & Wilcox Co.
Air Compressors—Joy Manufacturing Co. (Sullivan)
Compressor Turbines and Gears—DeLaval Steam Turbine Co.
Compressor Synchronous Motor — Westinghouse Electric Corp.
Stokers—Detroit Stoker Co.
Forced Draft Fans—Buffalo Forge Co.
Forced Draft Fan Turbine—DeLaval Steam Turbine Co.
Induced Draft Fans—Buffalo Forge Co.
Induced Draft Fan Drives—DeLaval Steam Turbine Co.
Deaerating Water Softener—Cochrane Corp.
Chemical Pumps—Dearborn Chemical Co.
Filter Backwash Pump—DeLaval Steam Turbine Co.
Continuous Blow Down System — Cochrane Corp.
Electric Motors—Westinghouse Electric Corp.
Coal Handling Equipment—Beaumont Birch Co.
Ash & Dust Handling Equipment—Beaumont Birch Co.
Instruments and Controls—Bailey Meter Co.
Dust Collectors—Western Precipitation Corp.
Platforms and Walkways—Tri-lok
Unit Substations—General Electric Co.

The deaerating hot process water softener, providing lime soda treatment for make-up water, can heat and soften approximately 84,000 lb of raw water per hr. Condensate returns to the unit at approximately 190 F and the total outlet capacity of deaerated boiler feedwater is approximately 253,000 lb per hr. Three chemical pumps are arranged to feed phosphate directly to the boiler drums. A fourth pump supplies tannin to the boiler feed pump suction. An electric timing device is used to regulate control of the chemical feed. There is a separate line for purging the chemical piping system with softened water after each pumping period to prevent clogging and insure accuracy of chemical feed.

The continuous blowdown system serving the boilers discharges flashed steam at 5 lb pressure to the 5 lb exhaust steam system. Blowdown water is discharged to waste.

Three centrifugal boiler feedwater pumps are each designed to handle 240 gpm at 228 F against a discharge pressure of 300 psi. Two of the pumps are direct-connected to steam turbines and the third to a 75 hp induction motor.

Coal is unloaded from railroad cars directly into an underground track hopper. It is then conveyed to a 300-ton storage bunker by automatic skip hoist with a capacity of about 45 tons of coal per hour. Excess coal is discharged from the bunker through an overflow chute and is stored in the adjoining yard. The storage yard is equipped with a cable drag scraper system accommodating 131 tons per hour on a 100-ft haul, or 50 tons per hour on a 300-ft haul. This permits either spreading the coal for storage or returning it to the track hopper and thence to the storage bunker. The complete system is operated from a control tower overlooking the yard.

From the cylindrical storage bunker coal flows by gravity onto a fully-enclosed, dust-tight belt conveyor. It is passed over a magnetic drum to screen scrap iron and falls into a weigh larry loading hopper equipped with a bindicator switch to stop belt travel when the hopper is filled. The motor-driven 2-ton weigh larry runs on tracks above the stokers.

The vacuum ash and dust handling system discharges into a 70-ton tile storage silo above the railroad tracks outside the building. A motor-driven rotary dustless unloader conditions the ashes as they are discharged from the tank into railroad cars.

Completely automatic combustion control regulates fuel supply, induced draft and forced draft. Damper control is used for the boiler that is equipped with the dual-driven

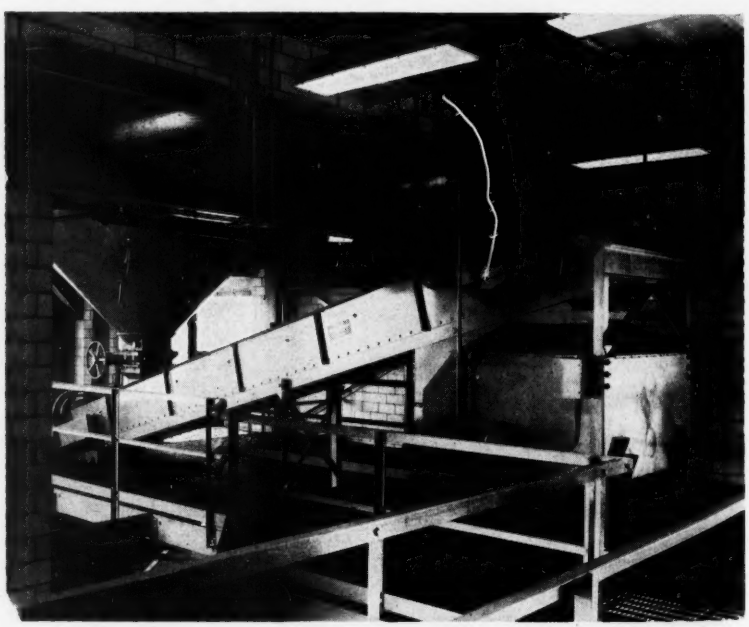


Fig. 6 This enclosed conveyor feeds coal from the storage bin into a larry-loading hopper (right). The latter is equipped with a bindicator that shuts off the conveyor motor when the hopper is filled

induced draft fan and the other boiler is regulated by speed control. Combustion air to the stoker is regulated by damper control on the forced draft fans in both boilers. Air for operating the automatic combustion control system is taken from the main compressed air header. For emergency service, however, an auxiliary motor-driven instrument air compressor is provided. It operates automatically on failure of the supply from the compressed air header. In addition to the usual boiler room instruments, flowmeters and gages are provided to indicate and record data on the various steam and compressed air systems.

Steam for space heating in the manufacturing building is provided at 20 psi. This steam is first supplied by the exhaust from the turbines driving the air compressors. Demand for 20 psi steam in excess of the amount available from this source is supplied by a pressure reducing station between this 200 psi main steam header and the 20 psi steam system. This reducing station with three reducing valves having a total combined capacity of 84,000 lb of steam per hr, operates automatically to maintain pressure in the 20 psi system. With this arrangement, steam demand for heating can be met continuously regardless of whether or not the compressor turbines are operating.

All auxiliary steam drives exhaust at 5 psi pressure. The 5 psi steam is used for heating feedwater. Any requirement for 5 psi steam in excess of that available from the steam driven auxiliaries is supplied by another automatically controlled steam pressure reducing station between the 20 psi steam header and the 5 psi exhaust steam header in the power house. In the manufacturing building, 5 psi steam is also used for some process work and for cooking in the plant cafeteria but this steam is reduced from the 20 psi main at its point of use.

Incoming electric service at 4800-v enters the building underground at a transformer vault in the basement. A 500-kva substation is used for power and a 100-kva, for lighting. Two "Pyranol" filled transformers serve each substation. These have built-in features permitting installation of automatic air cooling at a later date to provide increased capacity if required. Except for the synchronous motor driving one of the air compressors, which is operated at 4800-v, power is distributed throughout the plant at 440-v. All electrical equipment and wiring is protected against dust and excessive temperatures. "Fusetrons" are used throughout to provide a higher degree of safety for equipment. Emergency lighting units are located at strategic points. These flash on instantly upon loss of voltage of normal lighting and are self-charging battery units.

The power plant has five 30-in. diameter roof ventilators with motor-driven fans. Three serve the boiler room and two the compressor room. Other motor-driven ventilators are installed for the transformer room and locker room.

How We Arc-Welded a Steel Expansion Joint

By **FRED E. SCHUBERT**
Chief Engineer, Municipal Light Plant, Columbus, Ohio

IN OUR POWER PLANT we have several steam turbines, which have one or more copper expansion joints in the equalizing pipes, from 3 in. diameter to 12 in. diameter. We were continually fighting low vacuum but would eventually locate the air leak in one of these copper expansion joints in the equalizing pipe. Because of the position of these joints on the steam turbine, it was difficult to test them with water or with a lighted candle.

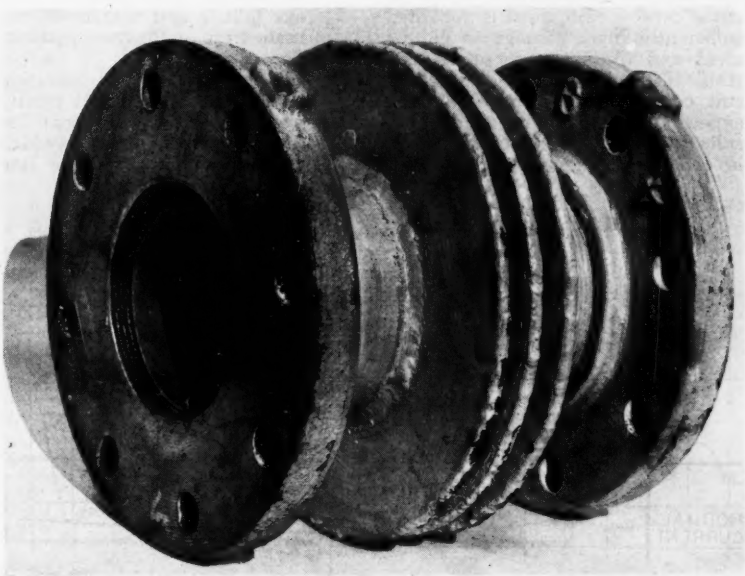
These copper expansion joints were rather expensive, costing up to $150 each, for about one year's service. It was annoying to have to be continually replacing them, and to install a new one entailed some extremely hard and hot work.

We solved the problem by producing, in our own welding shop, of our own design, a superior expansion joint, made entirely from salvaged steel, to replace one made of the conventional copper, which had been giving us an average of one year's service. Our home made steel product has now given us eight years' service, and is still absolutely airtight on high vacuum service on a 7500-kw steam turbine. Here's how we made the joints.

In scrapping a series of old capacitors at our plant, a series of ⅛-in. steel disks, with 3-in. hole and an outside diameter of 10 in., had been discarded. We rescued them and they proved to be ideal for a 3-in. expansion joint. Using six of these steel disks, we arranged them in pairs and arc welded the outer edges and inner edges as shown in the photograph. The welding caused the disks to take the shape of large saucers, producing just the right amount of flexibility; a man standing on the completed joint would cause the disks to flex back and forth.

After the steel disks were welded together, we used the end pieces, with flanges attached, from the old copper joint, cut to proper length and welded to the end disks, to complete the joint.

The home-made steel expansion joint offers just the right amount of rigidity and still is flexible enough to serve its purpose. Our results have been so outstandingly successful that I would like to pass the idea along to others. We use these disk expansion joints for any condition up to 50 psi and for high vacuum service.



View of expansion joint, fabricated by arc welding from discarded steel capacitor disks

ELECTRICAL WORK

High Voltage Motor Control

Need for protection in the operation of high-voltage motors . . . Effect of the development of high interrupting capacity fuse . . . Source of fault currents . . . Determination of fault currents . . . Coordination of control . . . Fuse sizes and selection

By R. C. THOMPSON, Chief Engineer, Control Division
Electric Machinery Manufacturing Company, Minneapolis, Minn.

IN THE PAST years one of the major expenses to owners of high-voltage motor installations has been the cost of the controls used to protect the motors against high-current short circuits. High-interrupting-capacity circuit breakers were expensive and their cost, in many cases, appeared to the owners too high to warrant their use. As a result, many did not protect their installations. Others did not think protection was necessary.

In recent years, however, more and more attention has been given to motor short circuit protection. Industrial owners have been coming to realize that adequate controls are needed to safeguard operating personnel and to protect equipment against damages.

Adequate controls are controls which are rated to meet the requirements of the system on which the protected equipment operates. If the control equipment is not rated sufficiently high, damage to equipment and injury to personnel can result if a high-magnitude short circuit occurs. This damage may be expensive to repair and usually results in loss of production. Hence, in considering the means of motor protection, owners naturally want a system that is both adequate and inexpensive.

The development of the high-interrupting-capacity fuse control system gives them their answer on both counts. This control meets the requirement demanded of the motor protection system in the usual industrial plant and has resulted in substantial savings in the first cost of the control. High-interrupting-capacity fuse control assures the following:

1—Short-circuit protection on systems rated up to 150,000 kva at 2300 v and 250,000 kva at 4160 v.
2—Correct motor overload protection by use of inverse-time-limit overload relays which are calibrated against motor thermal characteristics.
3—Complete under-voltage protection which takes the motor off the line in the event of voltage failure and which will not restart the motor upon restoration of voltage.
4—Maximum safety for operating personnel. The unit is totally enclosed, with interlocks on the fuse compartment door which takes the motor off the line when the door is opened. The high and low voltage compartments inside the cabinet are separated.
5—For synchronous motors, starting circuits automatically timed to apply excitation voltage at the proper time on the field-frequency cycle.

The motor overload relays protect the motor from currents up to 10 to 15 times full-load motor current. Fault currents which may occur, however, are of much greater magnitude than this. Several cycles elapse before over-load relays or circuit-breakers completely isolate the motor from this high-magnitude short-circuit current. During this time serious damage can result to the equipment. The purpose of high-interrupting capacity fuses is to interrupt this fault current before damage can result.

Source of Fault Currents

The magnitude of the fault current depends upon the capacity of the generating units feeding the fault, upon the system arrangement and upon the fault resistance.

The generators feeding the system usually maintain full voltage output during a short-circuit, and the current from this source is limited by the internal impedance of the generator and line impedance from generator to fault.

Synchronous motors may drive high inertia loads. When a fault occurs the voltage input to the motors ceases but the rotating, high inertia loads continue to rotate and drive the motors as generators. Hence, the synchronous motors on the line affected contribute to the short-circuit current. Induction motors also contribute for a few cycles and must be taken into account when considering high capacity fuses whose action is over in less than a cycle.

The resistance of a power system is generally small compared to the

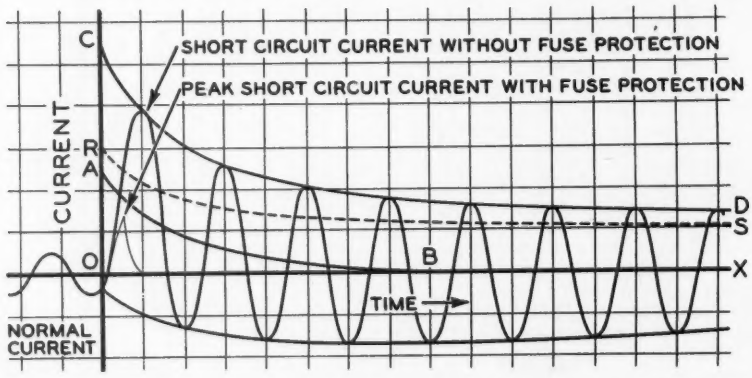


Fig. 1. Asymmetrical current wave resulting from a short circuit. The short circuit current reaches its maximum within the first cycle

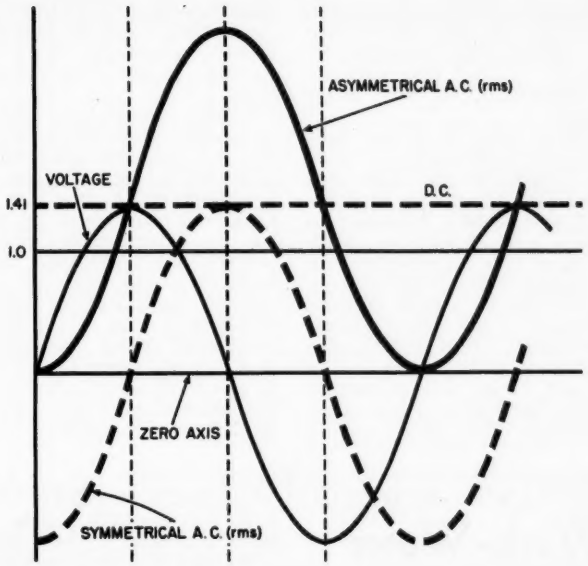


Fig. 2. The short-circuit value of asymmetrical current is worst when the short occurs just as the voltage crosses the axis, or in other words, voltage zero. To better understand the asymmetrical short-circuit current it is broken up into two components, a d-c and an a-c component. The dotted lines in the figure show these two theoretical components. The asymmetrical current has the d-c component for an axis and is symmetrical about it. The symmetrical component has the zero axis for its axis. Calling the rms, or effective, value of the symmetrical current I the peak value must be 1.41. This, of course, is also the effective value of the d-c component. The two currents are added by the root mean square method and the result is the effective value of the symmetrical short-circuit current:

$$I_a = \sqrt{I_{a\text{-}c}^2 + I_s^2} = \sqrt{(1.41)^2 + 1^2} = \sqrt{3} = 1.73$$

where: I_a = rms value of symmetrical current.
I_s = rms value of asymmetrical current.

reactance, hence fault currents are nearly 90 deg. out of phase with the voltage. When voltage is maximum, current is zero and when voltage is zero, current is maximum. This is of importance in understanding what occurs when short circuits take place on different parts of the voltage wave.

When the short-circuit occurs at voltage zero the current starts out at zero. Since the circuit is mostly reactive the current wave must be 90 deg. out of phase and of the same wave shape as the voltage. Hence, the current wave is displaced from the zero axis and is asymmetrical, not symmetrical, with the zero axis. The degree of asymmetry depends upon the part of the voltage wave where short-circuit occurs, being maximum at voltage zero and zero at voltage maximum.

The short-circuit current reaches its maximum within the first cycle as shown in Fig. 1. The asymmetrical current wave resulting may be simply understood by arbitrarily considering it as an a-c wave superimposed upon a d-c component and equal to the sum of the two. This direct-current component will be maximum if the fault takes place at zero voltage and will be equal to the peak value of the a-c current. If the short-circuit occurs at maximum voltage the d-c component will be zero.

Because of this d-c component, the a-c current wave is not symmetrical about the OX axis. The d-c component is a transient and decreases to zero within a few cycles, but, because the fuse interrupts the short-circuit within ½ cycle, it must be taken into account in applying the fuse.

The rms value of the asymmetrical wave, which is an a-c component superimposed upon a d-c component, is 1.73 times the rms value of the a-c component alone. This is shown in Fig. 2. However, the d-c component of the asymmetrical fault current wave decays to zero due to circuit losses and so a value of 1.6 rather than 1.73 has been selected from experience to be the ratio of rms asymmetrical current which the fuse interrupts to the rms short-circuit current. The value, then, of this instantaneous asymmetrical short-circuit current is 1.6 times the symmetrical value. The symmetrical value on a 3-phase system is determined by dividing the available 3-phase short-circuit kva by the product of the system voltage and 1.73. Fuses used on such a system should have an interrupting capacity of 1.6 times the system's symmetrical short-circuit current, because interrupting ratings of fuses are usually given as the maximum asymmetrical rms amperes that can be interrupted at the specified voltage and duty cycle. Also specified is the 3-phase kva rating of the fuse which serves as a comparison basis to the 3-phase kva rating of circuit breakers.

Fuses are specified by their E rating. The E rating is a standard that requires the fuses to melt at a current of 200 to 240 per cent of ratings and 300 seconds for fuses up to and including 100 amp. Fuses above 100 amp must melt in 600 seconds with currents of 220 to 264 per cent of ratings. They must also carry 100 per cent of rated current continuously without exceeding a rise of 30 C at the fuse clips.

Coordination of Control

Pre-engineering of fuse control requires careful coordination of high-interrupting-capacity current limiting fuses, the overload relays, and the motor switch. Fig. 3 illustrates how each component fulfills its requirements in coordination with the others.

It is frequently asked why a moderate-size motor switch or contactor can be used instead of the large-sized circuit breaker that would be required if high capacity fuses were not used. The answer to this is the high speed with which these fuses limit and interrupt the

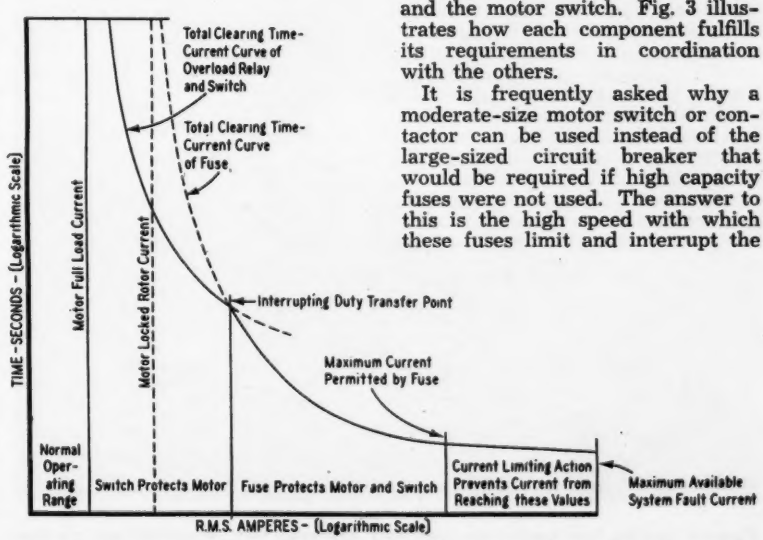

Total Clearing Time-Current Curve of Overload Relay and Switch
Total Clearing Time-Current Curve of Fuse
TIME - SECONDS - (Logarithmic Scale)
Motor Full Load Current
Motor Locked Rotor Current
Interrupting Duty Transfer Point
Maximum Current Permitted by Fuse
Normal Operating Range
Switch Protects Motor
Fuse Protects Motor and Switch
Current Limiting Action Prevents Current from Reaching these Values
Maximum Available System Fault Current
R.M.S. AMPERES - (Logarithmic Scale)

Fig. 3. These curves show how each component fulfills its requirements in co-ordination with the others

short-circuit current. Since the short-circuit is cleared in less than ½ cycles the total energy involved is low. Even under abnormal conditions where the peak value of current passed by the fuse is high enough to start opening the contacts of the motor switch or contactor, the circuit is interrupted so quickly that practically no energy is dissipated and no damage results.

Fuse Sizes

The high-capacity fuse control may be used on full-voltage, part-winding, or reduced-voltage starting on either induction or synchronous motors. When used on induction motors the field application and field protective equipment is omitted.

No expensive back-up breakers are needed when high-capacity fuses are used since the fuses provide individual short-circuit protection for each motor. Correct fuse sizes are chosen individually for each motor application.

The motor sizes on which these fuse controls may be used are limited by the maximum size fuse now available. The largest fuse available for 4160 and 4600-v operation is rated 200 E amp. Maximum inrush current must also be considered in determining fuse size, as well as the length of time of inrush current. When a motor is first connected directly across the line it acts as a transformer with its secondary shorted and, hence, a large current flows. This starting current is called inrush current. The controls may be used on motors rated from 50 to 900 hp at 2300 v and up to 1250 hp at 4600 v, depending upon starting-current inrush and accelerating time.

Fused, combination controls are completely assembled at the factory and are ready for installation. Controls may be used singly or may be combined for multi-panel control. Each control provides for main a-c bus, d-c excitation bus, control and potential bus. Additional units may be added at any time.

Since these controls were introduced their gain in popularity has been great. Motor users are finding very desirable their features of protection to personnel and equipment. The future will find very widespread use of this type of control.

Increasing Power Plant Wash-Water By Using Wasted Condensate

By LESLIE H. HOUSEL

HERE IS A desirable way in which one power plant increased the plant domestic wash-water supply, (water for the operator's wash-rooms and showers) and at the same time substantially reduced plant maintenance.

The conventional wash-water system is usually a pump of around 20 gpm capacity a filter block with a softener on the hot water side, and a 500-gallon tank on the roof. The discharge from the pump (in the basement) leads up to the roof tank and another line leads down to feed the system. This arrangement provides a constant pressure.

Such a system was originally used in a power plant containing 35,000-kw and 50,000-kw units. This system could have been increased with more and similar equipment to take care of plant growth; but instead it is now used for an auxiliary, and condensate that otherwise is usually thrown away is now used as domestic wash-water.

Throwing condensate away? Yes. Many plants are located on rivers, and these rivers are usually polluted with city sewage and industrial wastes. This makes the water high in ammonia content. This water may have to be used for the raw water and circulating water supply. Since ammonia is very soluble in water and will also readily change to vapor if there is a rise in temperature, it will show up in the main condenser both in the condensate and in the vapor. How this ammonia is disposed of and why condensate is thrown away are detailed below.*

Pure condensate would make ideal wash-water. But the condensate in question (drains from the inter-and after-condenser) is contaminated with ammonia, is undesirable for boiler feed, and is ordinarily discharged to waste for the reasons given.* However, it was decided to

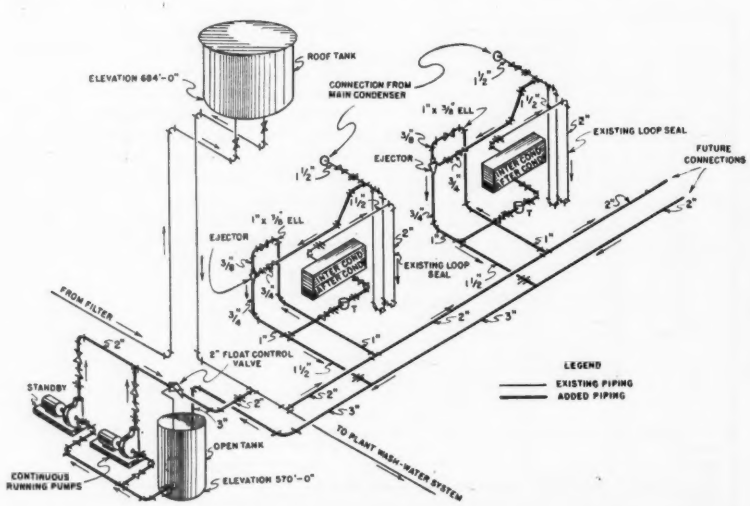


Diagram showing how condensate containing ammonia, from aftercondensers of main condenser air ejector system, is now used as plant wash water instead of being discharged to waste

* There are two important reasons for getting rid of this ammonia. One is that if ammonia appears in the system, the conductivity instrument in the condensate circuit will register an alarm. This instrument is primarily for detecting contamination in the condensate system; if for instance, condenser tubes break or are corroded through, allowing circulating water to enter the condensate system. Since that is its primary duty, and since the ammonia will cause a similar registration, it becomes important to get rid of the ammonia in order to have reliable indication of condenser tube leakage.

Second and more important reason is that ammonia causes corrosion. It will attack the condenser tubes when they are in air, causing de-zincification of the tubes. Ammonia attacks from the inside, being dissolved in the circulating water; and from the outside, being in vapor form in the condenser and in liquid form draining from the inter-condenser drain.

Most large plants use an inter and after-condenser to maintain vacuum in the main condenser. This unit exhausts air, *and any other gases*, from the main condenser, using venturi jets energized by steam. This steam-and-air mixture taken from the main condenser passes through the intercondenser, which condenses the steam, *and any other gases* (ammonia principally). The after-condenser exhausts the air from the inter-condenser, leaving it below atmospheric pressure. This means that normally the inter-condenser must utilize the vacuum of the main condenser to drain. Some plants trap the drains out and some use a loop seal. And the *condensate* discharge of the after-condenser is *thrown away*.

Since the raw water supply of many power plants is usually an adjacent river, it is objectionable as wash-water for obvious reasons. It may be muddy, odorous, and unquestionably full of bacteria. Usually the State Health Department will demand that water of a lower bacteria count be made available.

Use of chlorination or deepwell pumps in the plant referred to, posed equipment and maintenance problems. Other water or treatment had to be devised.

No mention has been made of CO_2 in the condensate because it would require a separate, though similar, discussion. In disposing of condensate as above, any CO_2 in solution in it would also be eliminated from the plant cycle.

use this water for the new wash water system because in any given amount of this water, ammonia content is small in comparison to what would produce smell and taste. And the wash water is discharged to waste anyway. It is the continued recirculation and concentration of such condensate containing ammonia, 24 hr a day continually, that make it corrosive.

The new wash water system is shown in the diagram. Since the intercondenser operates at pressure below atmospheric, a hydraulic ejector was selected to drain it. The present drainage system was left intact, but only as an auxiliary drain. Ejectors requiring 4 gpm at 40 psi were selected and installed immediately following the intercondenser drain, loop seal and valve between. The ejectors discharged into a common header dumping into an open tank on the basement floor. The trap discharge of the after-condenser was also fed into this line.

A continuous-running pump, fed from the open tank, discharges into the line coming down from the roof tank. This line is the source for the feeder lines to the ejectors as well as the plant wash-water system. The use of the line coming down from the roof tank permits the difference between what the ejectors use and what the pump is discharging to back up the line into the roof tank. So the roof tank acts as a surge tank, maintaining a constant pressure on the ejectors and the system. A new 1600-gal tank replaced the original 500-gal tank. Another pump was connected in parallel, for standby during maintenance or pump failure.

The inter-condenser jets use around 600 lb of steam an hour, so that each unit contributes about 1.3 gal of condensate a minute to the new system. In addition, there is the trap discharge of the after-condenser.

So as the plant grows and each new unit goes into operation, it will be connected in parallel with the new system, and will contribute its share to the plant needs. Most important, a source of plant trouble and maintenance is reduced.

Hydrocol Process Requires 80,000 hp in Compressors

IN THE HYDROCOL Process for manufacturing gasoline from natural gas, for which a plant is now being built by Carthage Hydrocol, Inc., at Brownsville, Texas, oxygen and natural gas are partly burned in a gas generator, Fig. 1, to produce synthesis gas. This synthesis gas is further compressed to a high pressure where it goes to the reactors. Because all the gas is not converted the first time through, a steam-driven centrifugal compressor is also required for re-cycling.

Reactions are exothermic and the heat withdrawn is used to generate steam in such large quantities that the process produces practically all its own steam power.

Compressors for this Hydrocol process are being manufactured and tested by Clark Bros. Inc. at Olean, N. Y. where some of the equipment was recently demonstrated to the technical press. Compression of air and gases will be performed by 24 units requiring total installed driving capacity of over 80,000 hp.

Two main compressors are centrifugal units, compressing 110,000 cfm of air to 100 psi, with a power requirement of 23,000 hp.

The compressors have been tested by driving them by a gas turbine now under development by Clark Bros., the turbine being supplied with gas fuel from the exhaust of a special gas-generator type of gas engine, consisting of 5 gas engine cylinders and three special oil-fired supercharged gas generator cylinders supplying gas to the gas turbine at 50 psi, 850-900 F, where it develops about 3000 hp at 3900 rpm for driving the centrifugal compressor under test.

Oxygen compressor for the Hydrocol 1000-ton per day oxygen plant is a 3-stage unit compressing oxygen from 17 psia to 370 psia, driven by a 6500-hp steam turbine. An expansion turbine is used to obtain refrigeration for cooling and partly liquefying air in the oxygen plant.

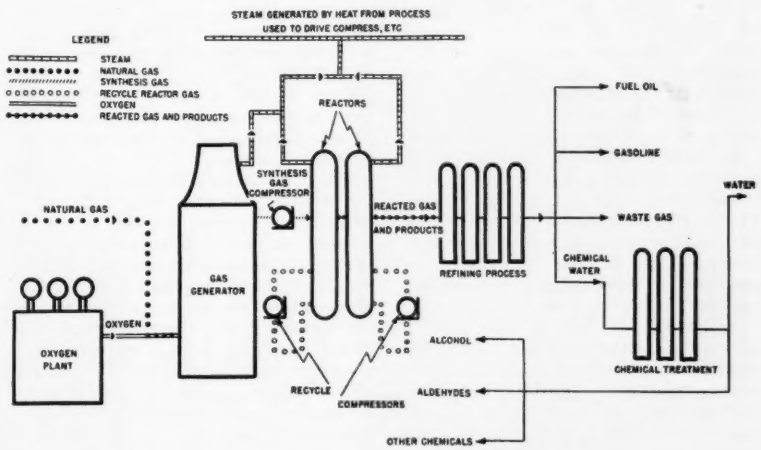


Fig. 1. Flow chart of Hydrocol process being installed at Brownsville, Texas

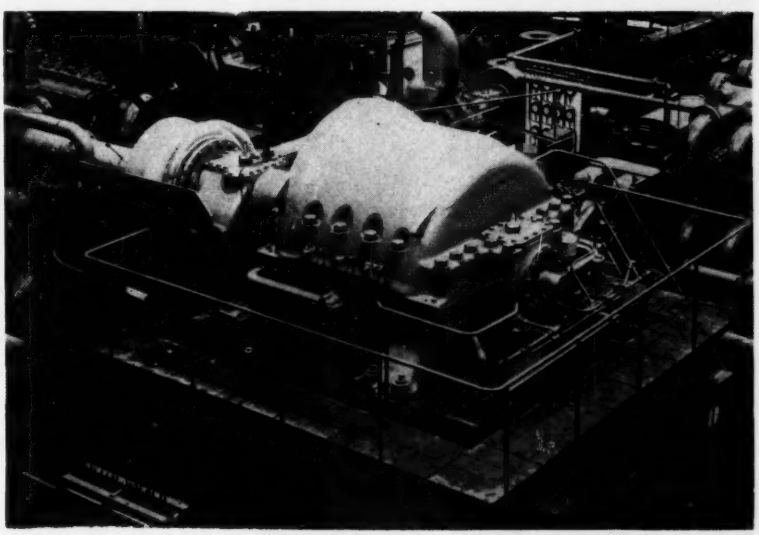


Fig. 2. Main air compressor for Hydrocol process consists of three 4-stage centrifugal cases in line, driven by 23,000 hp steam turbine, compressing 110,000 cfm of air to 100 psi for oxygen plant. This shows one of three cases on test floor of Clark Bros., Inc.

HYDROELECTRIC

POWER from PIKE'S PEAK

Hydro plant built in 1903, supplying power to the city of Colorado Springs, still in operation but it has been completely modernized. High efficiency is maintained by employing a novel method for cleaning the penstock

By ROBERT M. ORMES

THE CITY OF COLORADO SPRINGS, at the base of 14,000-ft Pikes Peak, derives from the mountain not only its bread and butter, its commodity of vacation attractions, but its water supply and much of its electric power as well.

The scenic Mount Manitou Incline Railway is itself a by-product of the arrangement for producing power. The cable-hung cars which whisk the prairie heated visitor up into the cool air of the mountains in record time were originally the conveyors for a pipe line.

From 1/5 to 3/5 of the power which the community and its nearby satelites consume is generated by routing its high altitude water supply through two hydroelectric plants. The lower step, which is the larger power source, utilizes a drop of 2420 ft from the intake settler to the two Pelton water wheels. Its effective pressure head of 2220 ft develops 5000 kw under the maximum flow of 35 sec ft.

Part of the water supply comes from the south slope of Pikes Peak. This is augmented by water diverted through tunnels from the west slope. The supply builds up during the winter in the form of snow banks; the heavy run-off of early summer is stored until needed in a system of lakes and reservoirs below the 11,500 ft timberline. From Lake Moraine, which is the lowest link in the storage chain, the water is piped down two and a half miles to an upper-level hydroelectric plant, where it has a static head of 1166 ft. When this pipeline delivers its maximum of 18 sec ft, it develops 1250 kw.

The water then goes into a settler tank, where it unites with side stream water to form the supply for the lower hydro plant. The settler tank is in Ruxton Park, just above the Halfway House on the Pikes Peak Cog Railway. It is circular in shape, 130 ft across and 10 ft deep. In the center there is a 36-in. screen-covered bell which tapers to the 22-in. inside diameter of the pipe.

There are two main laps in the downhill journey of the water from this point. On the first, it is led out of the deep valley of Ruxton Creek and taken around on a dipping contour to the front or east face of Mount Manitou, directly above the power plant. It loses about 800 ft in the course of two miles. To run the pipe on the straightest possible course, grade tunnels were driven through the subsidiary rock ribs and ridges of the mountainside, and grade trestles were run across the draws.

The second lap drops more than 1600 ft of altitude in less than 5000 ft of pipe. From the jump-off on Mount Manitou the line starts its plunge to the powerhouse at a grade of 68 per cent. Its shape resembles that of a half parabola as it bends upward toward the horizontal of the powerhouse floor. The natural convexities of the slope have been eliminated by deep trenching, so that the thrust of the water is all against the mountainside rather than outward from it. In addition to the concavity in the vertical plane there is one slight, long-radius curve in the plane of the mountain face.

Reinforced concrete anchorage for the pipe has been poured in at all points where the line is blasted out of solid rock. To take care of the thrust at the lower end, the pipe is buried to half-depth in concrete and

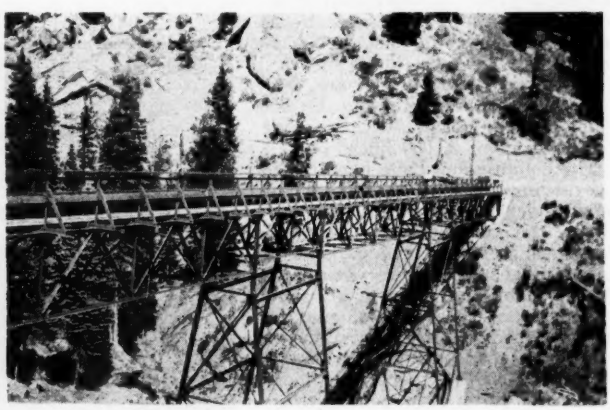


Fig. 2 (Above) To run the pipe on the straightest possible course, grade tunnels were driven through rock ribs and ridges, and grade trestles were run across the draws

Fig 1 (Left) Looking down from the Mount Manitou Incline Railway. The pipeline runs parallel to the tracks on the right side. The grade at this point is the 68 per cent maximum

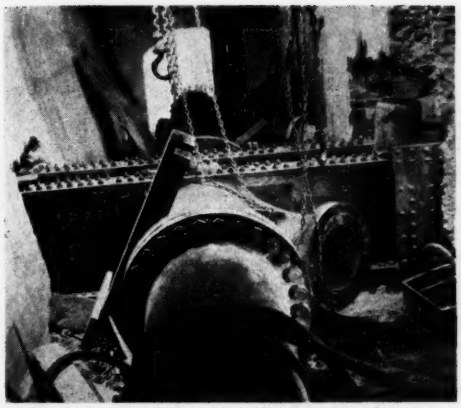


Fig. 3. Anchoring I-beam above the "Y" in the powerhouse alleyway

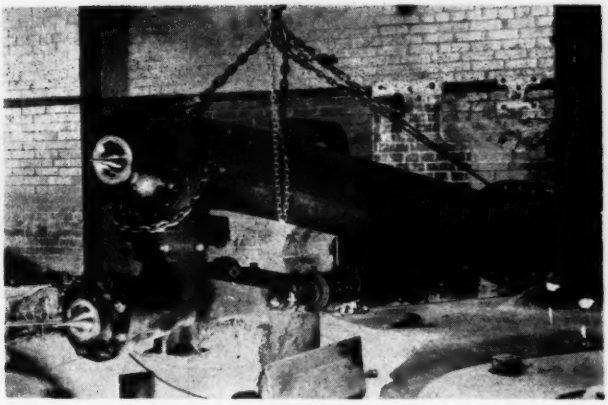


Fig. 4 The nozzle and the by-pass nozzle. The nozzle body is spherical

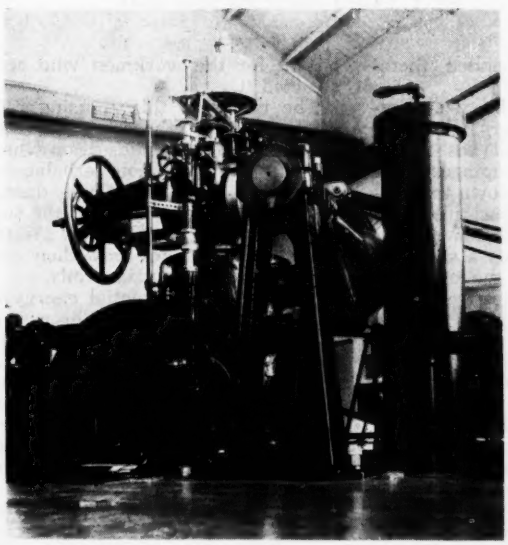


Fig. 5 (Left) A view of the governor and the controls for the jet

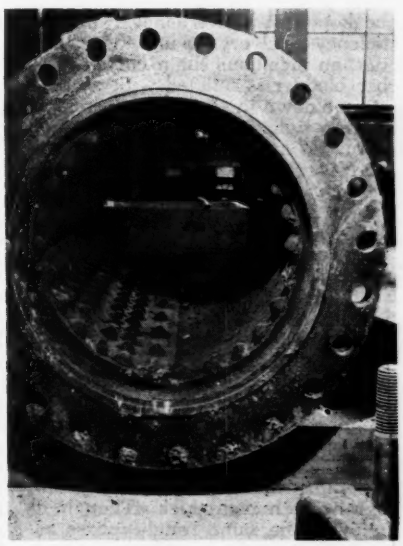


Fig. 6 (Right) A view looking through a section of the old riveted pipe

also held in place by I-beams bedded in concrete.

From the pipe, which has a 24-in. outside diameter, there are two Y's, each 14 in. in diameter, that carry the water off at a diagonal to the nozzles. The straight section is likewise tapered down to 14 in. after it passes the second Pelton wheel. When opened into the tailrace it can serve as a by-pass to permit repairing to either of the Peltons or generators.

The piping increases in thickness five different times between the settler and the power plant, beginning with quarter inch and running up to one and one eighth. The sections are joined by heavy flanges, drawn together by 28 one-inch bolts, and sealed by rubber gaskets.

The nozzle body is spherical. Its orifice is in a removable seat, three and a half inches across. When the two nozzles are running open each carries 17½ cu ft of water per second. The jet velocity is 395 ft per second, or 270 mph, quite enough to slice a man in half.

Since the power load is shared between the hydroelectric system and a steam plant, most of the burden of quick response to hourly changes in load has been shifted to the more elastic steam plant. The result is that almost all water passing through the hydro plant is utilized for power. There is however a by-pass nozzle under each of the Pelton wheel nozzles. The needle of the by-pass nozzle and that of the effective nozzle are rocker-connected, so that if the power load becomes light enough to increase dynamo speed, the Pelton governor commences to close the Pelton nozzle and open the by-pass. The full shut-off time of seven and a half minutes eliminates the possibility of water hammer. In practice, almost the only limitation on power generation has been the supply of water. In a dry season, when all possible storage water is being held in reserve and only the un-storable streamflow comes through, the Pelton nozzles are adjusted to run on as little as 20 per cent of their capacity without permitting the by-pass nozzles to open.

The original plant and pipeline were built in 1903, utilizing virtually the same pressure head as now. At that time the enterprise represented considerable pioneering as no comparable head was then used for power generation. From the time it was proposed until operation commenced, the project was under fire from doubters, among them engineers of good reputation.

The most serious bugs which developed were legal and administrative problems rather than faults of design. They related mainly to the mal-coordination of power generation and water use. However, there have of course been important improvements as one by one the parts of the system were replaced.

The original pipe, for example, was of necessity full of rivet heads. There was a single row around each end of each pipe segment to hold the flanges. Likewise the double butt straps which ran the length of the pipes had six rows of rivets, three on each side of the lap joint.

The welded pipe now in use is not only smooth to start with; it can

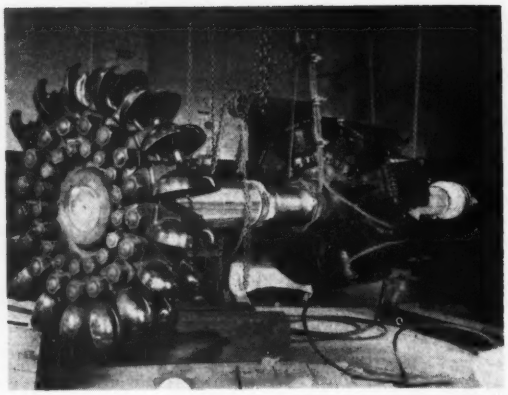


Fig. 7 Disassembled view of the Pelton wheel and the generator rotor

Fig. 8 General view of the power plant

be kept smooth. Whenever the efficiency dips very far into the seventies, an ingenious chain-coated rubber bladder is inflated with air and started down the long pipe. It makes a fairly tight fit, but when the water is turned in on it, it is forced along. As it is relatively buoyant, the water running under it imparts a backspin which causes it to scour the upper half of the pipe. When it has been run through thus, it is returned to the starting point and sent through again, this time full enough of water so that it does its scouring on the floor of the pipe. Mr. Harry Kliewer, who operates the hydro plant, reports that he has sometimes run the ball through a dozen times, and in the process removed a whole carload of rust barnacles.

The upper, less steep section of the pipe was originally only an eighth of an inch thick. Though it followed the same rough course as now, it wound around the ridges and into the draws so much as to lose a very large part of its effective head in overcoming pipe friction. The 4775 ft of so-called pressure pipe which began at the face of Mount Manitou, increased to three-fourths of an inch at the powerhouse, instead of the present one and one-eighth. The gasket used on this line was an alloy of one part tin and one part lead. It was set in a groove, half an inch deep and an inch wide, which was counterbored into the face of the flange. On the opposing flange an annular lug was turned which projected three eights of an inch from its face and could be fitted against the alloy in the groove. In the rather loose-fitting joint, the gasket of lead alone, which was originally intended for use, was found unable to resist the pressure of 940 lb developed at the lower end of the line.

The nozzles used up to 1939, instead of being provided with a bypass pipe, were equipped with a ball joint so that the jets could be deflected downward until they completely missed the buckets of the waterwheels and expended themselves in the tailrace.

The bucket design has been improved in the laboratory which the Colorado Springs plant has turned out to be. The jet impinges on a double bucket, ridged down the center to split it and throw the water to the two sides. Mr. Kliewer's alteration, which is mainly a sharpening and reshaping of the outer lip of the bucket where the stream first begins to strike it, has resulted in smoother jet impingement and longer life for the buckets.

When the pipeline was constructed it was found expedient to put in the 30-in. gage tramway which was later converted to a tourist joyride. This runs from near the powerhouse directly up to the brow of Mount Manitou, on a course so steep that special anchoring holds had to be put in for the workmen who constructed it.

The tracks of this amusing railroad consist of three parallel rails except for a short midsection where the two mutually counterbalancing cars pass. One car has double flanged wheels on one side; the second has them on the other. At the switches, the flanges draw their cars to the opposing outside rails.

Not all of the potential energy of the Colorado Springs water system is utilized. To take care of its population growth, the city has recently added water from the north and east slopes of Pikes Peak. This supply is also picked up at high altitudes, and though there is little possibility of using so steep a drop as occurs on Mount Manitou, considerable of the power can be harnessed when a suitable time comes.

Spirally interlocking strips of tough Tenite plastic are eliminating lots of headaches for power concerns. Purpose of the strips is to form protective sleeves for existing power lines. No special tools are required for installation, and quantities of the strips can be handled conveniently by a single lineman. To install, simply apply the ends of both strips around the wire and spiral the two lengths together. In place, they form a tubular sleeve, which is flexible and lightweight, and provides excellent protection against abrasion by trees and other hazardous obstructions

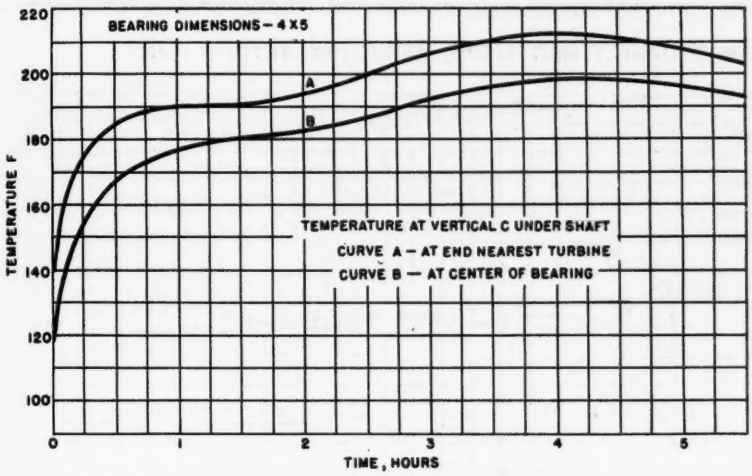


Fig. 1. Curves of babbitt temperature vs time in high pressure bearing, unit shut down and oil shut off after turbine operation at 720 F

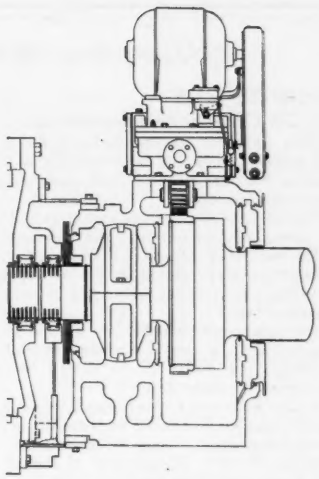


Fig. 2. Details of turning gear assembly as used on industrial steam turbines

How to Operate Industrial Steam Turbine Oil Systems for Best Oil Performance

Precautions in starting and stopping turbine and in running on turning gear . . . When using inhibited or non-inhibited oils, use oil conditioning equipment, test oil samples at frequent intervals . . . What the tests will tell you about sludge, dirt, life of oil, when to "sweeten" the oil, emulsions . . . How to keep system clean, remove corrosion, repaint . . . This is last part of series that started in the April issue

By **FRANK C. LINN**, General Electric Co.

FOLLOWING PRECAUTIONS should be taken relative to the oil and some parts of the lubricating system during starting and stopping cycles of industrial turbines.

Loading on the bearing may be as high as 150 psi to 250 psi, so oil must be at the bearings at temperature of 70 F to 90 F during starting and stopping cycles while the unit is operating under 500 rpm.

Starting Industrial Turbines

Before starting, oil should be observed leaving the bearings through the sight flows; and the pressure gage in the bearing oil header should read over 10 psi.

During the warm-up period, the turbine is run between 400 and 500 rpm for from 40 min to 1 hr and the oil going to the bearings or leaving the cooler should not be over 90 F. With this precaution, viscosity of the oil will be high enough to allow the unit to be shut down, if necessary for any reason.

When the unit is brought up to speed, cooling water should be turned on when the temperature of the oil leaving the hottest bearing reaches approximately 140 F. Water to the cooler should be regulated to maintain the bearing inlet temperature of 110 to 120 F while the unit is at speed.

Seldom will the outlet temperature of two bearings be the same, because the temperature rise of the oil as it passes through a bearing depends upon many factors such as oil flow, clearance ratio, smoothness of the bearing and journal surfaces, and the like. Orifices are used in the inlet to the bearings, to limit the flow to give approximately a 30 F temperature rise; except that the smallest orifice used on industrial turbines is $\frac{1}{8}$ in. On bearings 6½ in. or less in diameter, temperature rise in general will be less than 30 F for 3600-rpm operation.

Stopping Industrial Turbines

When shutting down, water should be left on the cooler to bring the temperature of the oil to the bearings to approximately 90 F by the time the rotor speed is reduced below 500 rpm.

When the turbine stops, water to the oil cooler should be shut off but oil to the bearings should be left on until the turbine cools down, to keep the babbitt temperature at a satisfactory value. Figure 1 is a plot of babbitt temperature vs. time of a high-pressure bearing, with the unit shut down and oil shut off after operating with a first stage shell temperature at 720 F. Temperature of the babbitt did not start to drop until 4 hr after shut-down; and then the drop is gradual.

A good rule is that oil should be left on the bearings where the inlet steam temperature is over 700 F and/or the exhaust temperature is over 500 F. Length of time to leave oil on the bearings will depend on steam temperature and on amount of heat resistant lagging on the casing, and will have to be determined by the operators. It is advisable to keep the babbitt temperature below 200 F.

As steam temperature increases, more heat flows along the shaft to adjacent bearings. On high-temperature units oil flow must be increased to these bearings to keep the temperature rise to less than 40 F. The manufacturer does this by increasing inlet orifice size.

Turning Gear Operation

Some users of industrial turbines desire turning gears, Fig. 2, on their equipment. The use of turning gears on industrial turbines should be-

Operating Items to Watch When Using Inhibited Turbine Oil

INHIBITED OILS

1. Oil Conditioning Equipment:

(Use of water washing or clay filters is *not* recommended with inhibited oils as they remove the rust inhibitor and some oxidation inhibitors used.)

The oil conditioning equipment should be in continuous operation. The amount of water separated should be observed and, if excessive, steps should be taken to determine the source of the water and preventive measures taken.

The equipment should be internally inspected once a week. If sludge formation is found, the batch of oil should be replaced at an early date.

A few industrial turbines must be kept in service over long periods. In those, if sludge is observed, the oil can be sweetened by drawing off 10 to 20 per cent of the oil in the system and replenishing it with new oil. This will keep the oiling system, including the oil cooler, free from sludge.

2. Oil Sampling

A sample of oil should be taken at 3 to 6 month intervals and the following tests made:

Viscosity; Acid Number; Interfacial Tension; Steam Emulsion Number; ASTM Corrosion Test; ASTM Oxidation Test (Test at 6 to 12 month intervals)

A plot of test results vs. time should be made, for a change in the magnitude of an item indicates that action should be taken.

Increase in the viscosity usually indicates sludge formation. The increase usually takes place after an increase in acid number.

Increase in acid number beyond 0.25 nn indicates that the oxidation inhibitor is used up—or practically so.

Decrease in interfacial tension after considerable operation usually indicates approach to the end of useful life of the oxidation inhibitor. This change may or may not occur previous to an acid number of 0.25 nn.

Increase in the emulsion number to 300 or 600 is usually caused by contaminants getting into the oil. These usually can be removed by the oil conditioning equipment and the steam emulsion number reduced to less than 200 to 300. Even with higher values, the oil may operate without the formation of emulsions.

The ASTM corrosion test should be made. If a few rust spots occur, it indicates that some of the rust inhibitor has plated out, but does not necessarily indicate that rusting will occur even though water is present in the system. If a number of rust spots occur, the oil supplier should be contacted so he can supply a rust inhibitor concentrate for the system.

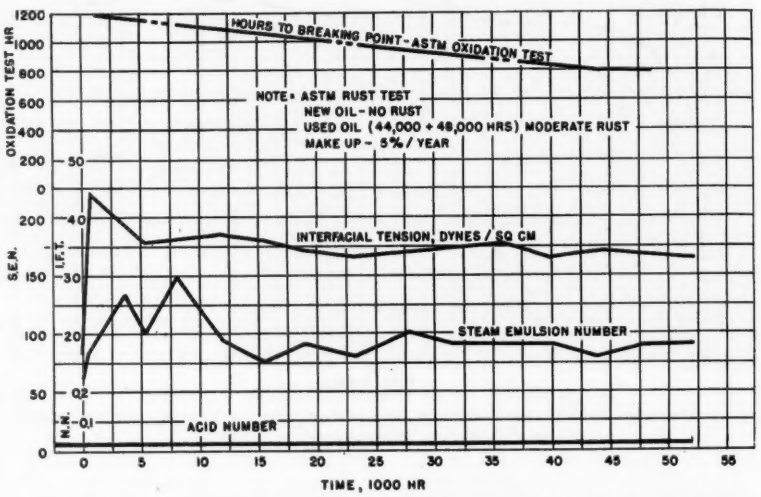


Fig. 3. Curves of performance of inhibited oil in 7500-kw 400-psig, 750-F, 1-in. Hg abs, 3600-rpm turbine generator set

The ASTM oxidation test was developed to determine the number of hours required to have a new oil operate at test conditions to obtain an acid number of 2 nn. This test has later been used to determine when a used oil will arrive at an acid number of 2 nn. A plot of time vs. service time gives an indication of the remaining service hours that the oil can be used before the inhibitor has been used up.

These test results do not necessarily indicate the remaining time before sludge will be formed. However, observation of the dirt in the oil conditioning equipment, at the weekly inspection, will give plenty of warning, in addition to these test results, to allow the operator to care properly for the lubricant.

3. Records and Test Results

a. Record oil temperatures to and from the bearings.

b. Record amount and date of makeup oil added.

Results of tests of samples on a commercial unit with an inhibited oil are given in Fig. 3.

4. Cleaning Lubricating System of Existing Installations

Yearly inspection of the oil coolers, oil tank, return oil lines, governor mechanism, bearings and pedestals is good insurance, to assure that rust, sludge, or other foreign matter are not accumulating in the oiling system.

If foreign matter is found, it should be removed by hand cleaning or by flushing, as outlined in Part I April issue, for new installations.

We have turbines in our power plants of from 5000 kw to 10,000 kw rating, which average 8000 hr operation per year and which have remained clean since inhibited oils were put in them 4 to 6 years ago. The oil has never been removed from the tank and the oil conditioning equipment has never been used. A monthly inspection of the oil shows it is in a satisfactory condition. Data for Fig. 3 were obtained on the oil from one of these turbines.

The oil in these turbines should continue to operate many more years, based on tests to which they are subjected, and which we have recommended in this article.

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come more prevalent as the kilowatt rating of the unit is increased.

A motor-driven turning gear rotates the shaft at low speed when the unit is out of service. By rotating the shaft slowly during the starting up and shutting down cycle, the shaft can be maintained straight during the time the unit is hot, and can be straightened if for any reason it has become distorted due to uneven heating while not rotating.

Shaft speed during turning gear operation is in the neighborhood of 1 to 3 rpm, so bearing oil inlet temperature must be held less than 90 F to keep the bearing metal cool and to provide oil with sufficient viscosity to lubricate the bearings.

When turning gears are used, a separate oiling system is provided for turning gear operation, so the regular auxiliary oil pump must be started before putting steam on the turbine.

Worm and Gear Lubrication

Worms and gears are extensively used on industrial turbines to drive a vertical shaft and reduce its speed from that of the horizontal main turbine shaft to approximately 600 rpm. The vertical shaft carries the operating governor and usually drives the gear oil pump.

They have been, in general, satisfactory; however, there are some applications where considerable trouble has been experienced. Some of these cases have been corrected by directing the oil stream to the point of mesh, so that there is a large volume of oil to cool the mating surfaces and provide a supporting film.

The oil nozzle should be placed as near the meshing surfaces as possible to eliminate the possibility of windage deflecting the oil stream away from the mesh.

Cleaning of Oil Cooler Bundles

Oil cooler bundles have been cleaned by pickling in acid and caustic solution as well as steam cleaned.

After cleaning, the bundles MUST

(Continued on page 114)

Operating Items to Watch When Using Non-Inhibited Turbine Oil

NON-INHIBITED OILS

Where non-inhibited oils are used, following are some of the items which should be given attention.

1. Oil Conditioning Equipment

(Water washing or clay filters have been used to good advantage in some installations with non-inhibited oils)

The same practice is recommended as for inhibited oils, except that some sludge formation can be expected after a few thousand hours operation. This can be controlled by water washing or clay filtering and, if not severe, by centrifuges, cartridge and bag type filters and by filter presses. Some companies are reporting that today the only way to keep the acid number within the range of 0.5 to 1.0 on conventional oils is by the use of clay filters; so their use with these oils has increased during the past few years.

2. Batching

Batching is accomplished by having two tanks into which oil from turbine systems can be drawn and allowed to rest. Oil is drained into the empty batch tank from a turbine when it is closed down. Oil is put into the turbine oil tank from the full batch tank. Sludge, water and foreign matter settle to the bottom of the batch tank and are drawn off and a like amount of new oil added. With two or more turbines in a station, it is possible to have a cycle for changing the oil in the various turbines to and from the batch tanks. By this method many systems have operated for years with from 50 per cent to 100 per cent makeup per year but without serious sludge problems.

3. Oil Sampling

A sample of oil should be taken monthly and the following tests made: Viscosity; Acid Number; Interfacial Tension; Steam Emulsion Number; Rusting Test.

A plot of the values obtained from these tests against time will show changes taking place in the lubricants.

Increase in viscosity indicates an increase in oil soluble acids.

The acid number will increase with time and it can be controlled by filtering, batching and sweetening.

Some conventional oils will operate satisfactorily with an acid number of 2 or more; but if water or other foreign matter enter the oiling system, there is danger of rapid formation of emulsions or sludge, which may necessitate shutting the unit down for a major cleaning operation of the oiling system.

Some operators use the interfacial tension test to determine when to replace or sweeten a batch of oil. They make a change when the oil has arrived at a value of 18 to 20 dynes per sqe cm. By so doing they have kept their turbine systems free from sludge deposits.

If the steam emulsion number remains at a high value after proper operation of the oil conditioning equipment, it may mean that emulsions will form rapidly in the presence of water. If high values are obtained, sample the oil frequently to make sure that emulsions are not forming, if it is inconvenient to replace the batch of oil.

Most oils that have not been inhibited with a rust inhibitor will not pass the ASTM rust test when new. Oils that also do not have an oxidation inhibitor quickly oxidize and form molecules that coat the metal surfaces and protect them from rusting in the presence of water. Because of this molecular change, a conventional oil after only a few months service will pass the ASTM rust test.

A few operators have used an oil with only an oxidation inhibitor. Many months may elapse before sufficient molecules will be formed to give rust protection.

In the latter 1930's, many operators adopted the practice of adding 10 per cent used oil to a batch of new oil, where a rust inhibitor was not used, to prevent rusting. This practice is questionable, since at last 50 per cent of the life of the oil has been eliminated due to the 10 per cent used oil addition. However, this practice is essential if conventional oils are used on new installations.

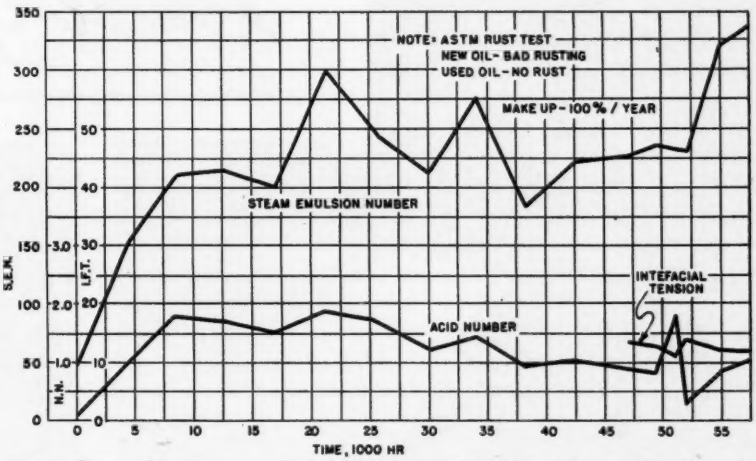


Fig. 4. Curves of performance of non-inhibited oil in 10,000-kw, 180-psig, 550-F, 2-in. Hg 1800-rpm turbine generator set

4. Records and Test Results

Record oil temperatures to and from the bearings.

Record amount and date of makeup oil added.

Results of tests of samples on a commercial unit with a conventional oil are shown in Fig. 4.

5. Cleaning Lubricating System of Existing Installations

Six-months' to a year's inspection of the oil cooler, oil tank, return oil lines, governing mechanism, bearing and pedestals is good insurance against accumulation of rust, sludge, or other foreign matter.

Cooler bundles, Fig. 5, are usually the first part of the system to get dirty. A gradual temperature rise of the oil leaving the cooler, for a setting of the water valve, usually indicates the cooler tubes are becoming coated.

A dirty system should be given a thorough cleaning. Following methods may be used: a. Hand cleaning; b. Cleaning with low pressure saturated steam or hot water; c. Flushing with turbine oil; d. Flushing with highly-solvent flushing oil and then with turbine oil.

Dirty oil systems generally can be thoroughly cleaned by dismantling the piping and blowing saturated steam or hot water at from 50 to 150 psi through them and into the pedestals and tank. After cleaning with steam or hot water, lintless cloths should be drawn through the pipes and used to wipe out the pedestals and tank.

Some oil companies have developed flushing oils or cleaners, which have good dehydrating properties and high solvency for oil deterioration products. These flushing oils will break up oil-in-water emulsions, remove loose rust and other solid matter from the system, and a rust inhibitor protects freshly exposed metal surfaces as they are cleaned.

Solvent cleaning is effective where it is undesirable to dismantle the oiling system.

It is recommended that flushing with "cleaners" be done only under the supervision of the oil company's representative.

After all cleaning or flushing operations, some hand cleaning may be necessary to remove accumulations in the pedestals or tank. This should be done by lintless cloths.

As soon as cleaning operations are completed, the freshly exposed metal surfaces should be protected against rusting. This can best be done by the use of oils with rust inhibitors present.

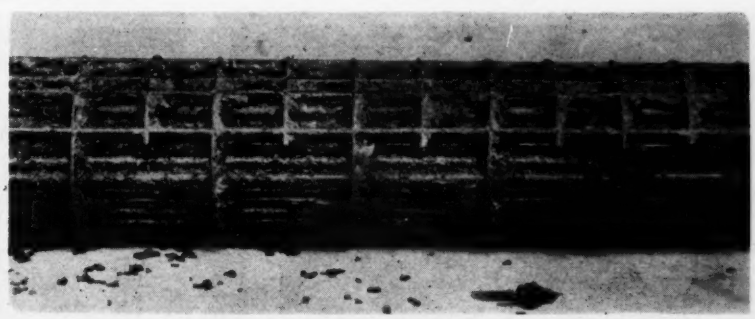
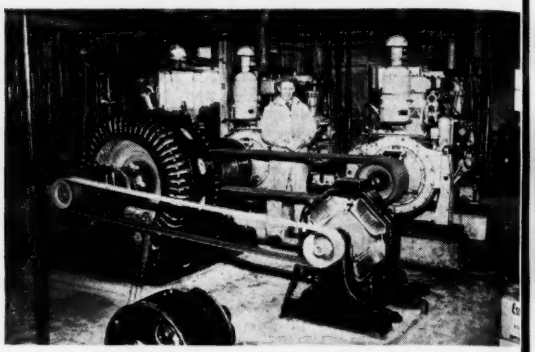


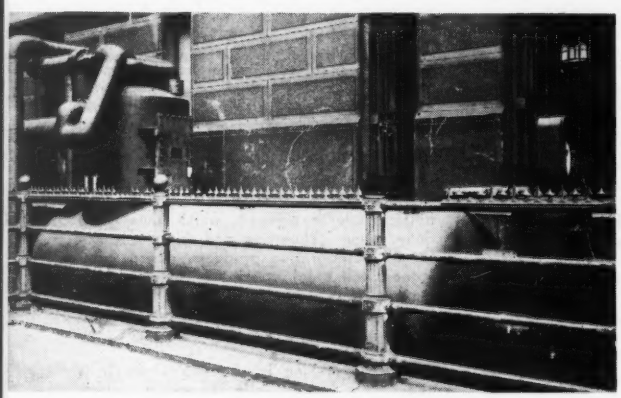
Fig. 5. View of dirty oil cooler bundle, usually first part of system to get dirty

Power Generation

The bar of engineering judgment—a view in the dynamometer car behind Alco—GE 4500-hp gas turbine locomotive during road tests this spring. Here the test men recorded all phases of the unit's performance. Turbine fuel is Bunker C fuel oil. This is first locomotive gas turbine to go into operation in U. S. and first purely power generating application. (See PG, July 1949)

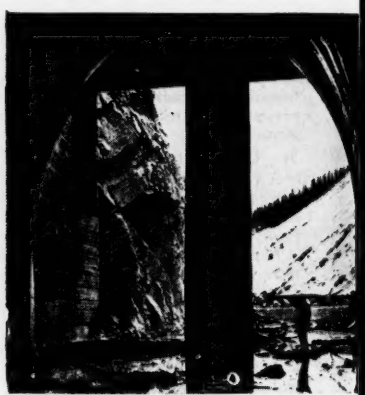


Two Caterpillar Diesels drive 125-kw Westinghouse generator with multiple V-belt through twin-disc clutch, so that either or both engines can drive the generator; installation at Dominion Fire Brick & Clay Products, Ltd., Claybank, Saskatchewan, Canada



This "tank car without wheels" is a Cochrane, 75,000-lb-per-hr deaerating heater installed just outside the subway exit, southeast corner City Hall Courtyard, Philadelphia, Pa. Removes dissolved oxygen from boiler feedwater; note feedwater meter at right; installed as part of recent modernization program

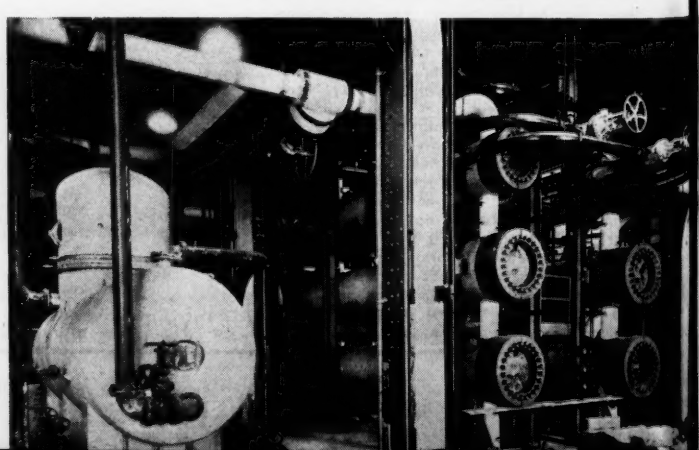
S. D. Distelhorst of Cochrane got this shot of the deaerating heater (left) en route through archway of Philadephia's City Hall



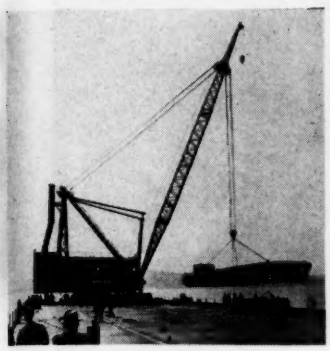
Probably last picture taken from inside inlet of 36-ft diameter diversion tunnel at Bureau of Reclamation's Hungry Horse Dam. Flathead River started through it in April

Near the Bonny, Bonny Banks of Loch Lomond is rising this 1200-ft long, 160-ft high dam at Loch Sloy, part of extensive development of Scottish hydroeletric power. Water from Loch Sloy will flow through Ben Vorlich (mountain) to a power plant at Loch Lomond

Wrought iron pipe was used liberally in the construction of an addition to the Huntley Station generating plant of the Buffalo Niagara Electric Corp., a section of which is pictured below. Included in the photo are a 6-in wrought-iron house water service line and some of the downspouts. Other wrought-iron applications include soot removal and evaporator blowdown



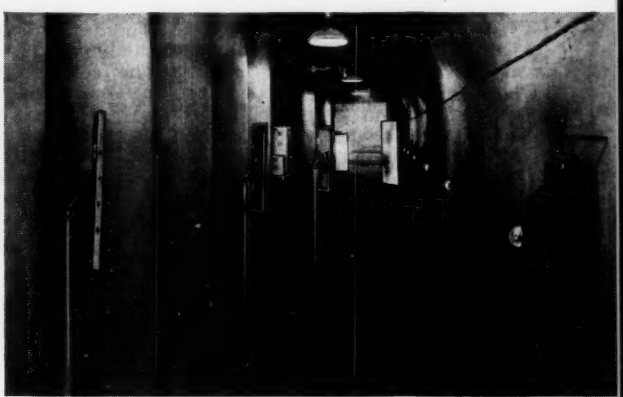
NEWS REEL



Largest floating crane of its type in this country is steam powered from Titusville Scotch Marine SPO-200, 150-psi, boiler. Lifting capacity 150 tons, 80 ft radius

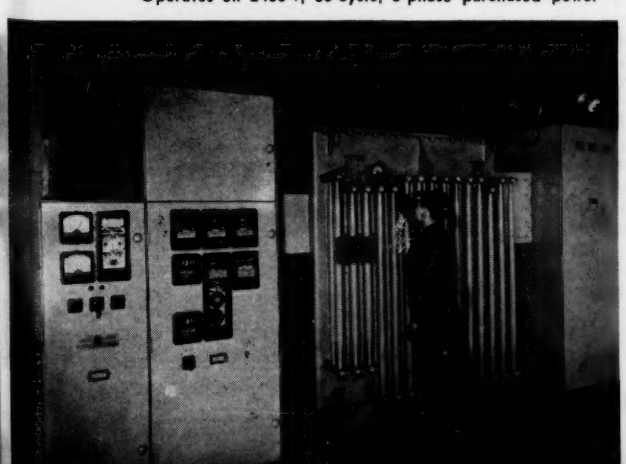
At new Tidd plant of Ohio Power Co. at Brilliant, Ohio (See PPE, March 1947) the Diamond Utiliscope (wired television) is now being used for observing pilot burner flame conditions. Control room operator has push-button control of all equipment in lighting off and operating burners, replacing former use of two operators communicating via public address system. Utiliscope views of flame conditions increase safety and operating efficiency

Walk-in housing for 125-kw main and 3-kw pilot exciters to go on standardized Allis-Chalmers turbine generators; provides walk-in accessibility and added personal safety. AIEE-ASME Standardized units now in production, in capacities from 11.5 mw (air cooled) 20 to 60 mw (hydrogen cooled)

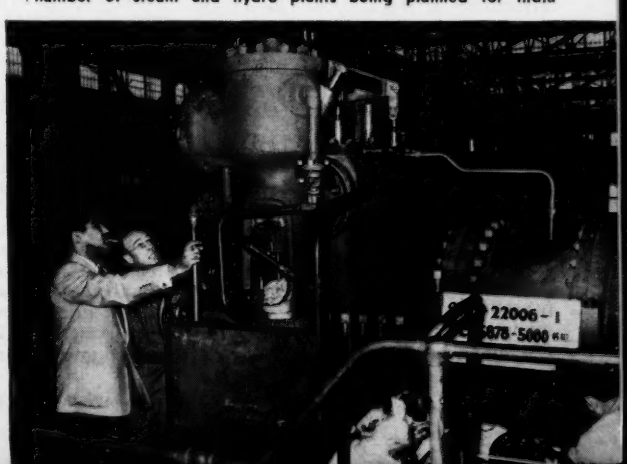


Utiliscope indications of pilot burner flame conditions, shown above on boiler control board at Tidd Plant, originate here. Six cats-eyes (right), showing whether burners are on or off, are watched by one Diamond Utiliscope camera (center rear) using mirrors to pick up reflections

Installed in 1946 to replace obsolete steam electric generating equipment, this GE ignitron rectifier, rated at 300-kw, has reduced cost of power from 37½ cents per ton of coal to about 23 cents per ton in two years at Vinton Coal & Coke Co., Vintondale, Pa. Operates on 2400-v, 60-cycle, 3-phase purchased power



Standing by throttle valve, Yudi R. Nanda (left) managing director Escorts (Agents) Ltd., looks over 5000-kw packaged steam turbine generator unit being built at Sunnyvale, Calif. plant of Westinghouse for installation in India. This is only one of a number of steam and hydro plants being planned for India



Here's How They Train Power Plant Operating Engineers in Cleveland

Fig. 1. View of a class session in Cleveland's steam power plant engineering course

TODAY'S POWER PLANT operating engineer must know vastly more of the why's and how's of his equipment then the operator of 25 years ago. A strong back, for wielding a coal scoop or sledge or slice bar, is no longer a primary requirement. The power plant man of 1949 works mostly with his brains; and the better they are stocked with power plant knowledge, the better the operation will be.

With full realization of these facts, which have been impressed on them more and more strongly in recent years, power plant operating engineers in the City of Cleveland, Ohio are engaged in one of the most unusual and effective co-operative adult education programs being carried out in this country today for educating young men in the fundamentals of power engineering.

It is the 4-year steam power plant engineering training program conducted jointly by the International Union of Operating Engineers, (IUOE) Local 589 and the Board of Education of the City of Cleveland, with the active sponsorship of 42 of the leading industries of Cleveland and the encouragement and active support of the Bureau of Apprenticeship of the U. S. Department of Labor.

Effectiveness of this course for the young man interested in getting ahead in power plant work was clearly demonstrated at a class dinner of apprentices at the Hotel Statler, Cleveland, on June 22. About 75 members of the class were present, with their families, also many engineers representing the Cleveland industrial plants co-operating in the program, union officials, members of the Cleveland and Ohio state educational departments and the U. S. Department of Labor.

The apprentices in the course were unanimous in their praise for the help the program has given them. A typical case is that of one young man who started as an oiler, took the steam power plant training with honors, is now chief operating engineer for a large Cleveland industry and is studying further at Case Institute of Technology to prepare himself for examination for licensing as a professional engineer.

Typical of the cordial co-operation of industry in the plan was the praise given the training by plant engineer of a large industrial plant, who now has a number of those who have completed the program working very effectively in his power plant.

Details of Training Program

The idea of this program was fostered by the IUOE, Local 589, and especially by Frank P. Converse, the union's international vice-president, who was instrumental in getting the program started in 1941. The school to provide the related instruction was placed under the active direction of William H. Engelman, mechanical engineer in the Department of Water & Light of the City of Cleveland, graduate of the Polytechnic Institute of Bremen, Germany, member ASME and licensed professional engineer. Mr. Engelman teaches the classes in steam and mechanical subjects, while H. G. Kunz, electrical engineer in the Cleveland Department of Water & Light, and a graduate of Case Institute of Technology, handles most of the electrical work.

The idea is this: Instruction in steam engineering is intended to train the apprentice in fundamentals of steam and electrical work and not merely to prepare him to pass the Ohio operating engineers' license examinations. For these license examinations, separate instructions are given on an individual basis, since length and type of service are a factor here.

The steam engineering course, on the other hand, is part of a carefully co-ordinated apprenticeship program in power plant operation. It is a four year course of 144 hours per year and must be taken as part of an apprenticeship program that includes full time power plant work under an apprenticeship agreement. Any individual working as an ap-

prentice in power, refrigeration, heating, air conditioning or allied fields is eligible to enroll. He need not be a member of IUOE, although naturally he will be urged to join it. If he does so, he will be urged by the union to enter the apprenticeship program. The course is approved for veterans under the GI bill.

This apprenticeship program is administered by an area operating engineers joint committee, and in each plant where apprentices are employed there is a plant operating engineers joint apprenticeship committee. These committees are made up of members representing both the employers and the union. The area committee supervises the entire program for the Cleveland area, while the plant committee is responsible for the apprentice in each plant, to assist him in making progress and solving his problems.

Apprenticeship is by written agreement between the apprentice and the area committee, all as approved by the Ohio State Apprenticeship Council and set up with the active co-operation and counsel, whenever necessary, of the Bureau of Apprenticeship, U. S. Department of Labor, of which O. R. Poole is supervisor of the Cleveland area.

The object of this apprenticeship training is, of course, to insure that there will be a sufficient number of properly educated young men coming along to operate present and future power plants. The plan assures the able man of a chance for advancement; it provides the union with well-trained men it can recommend to the employer; and it provides the employer with security against lack of proper personnel because he himself is co-operating in their development.

Course Co-ordinated with Every-day Work

Every effort is made in the steam engineering training course to co-ordinate the work of the course with the actual problems of operation encountered by the student in his daily work. The class work is done at night, entirely outside working hours, and without pay, utilizing classrooms and facilities made available in the Cleveland Trade School by the city's board of education.

The student must serve a four-year apprenticeship and an additional minimum of 144 hours per year of related instruction. For the first 3 months he is on probation. He must be an American citizen of legal working age, preferably a high school graduate or with equivalent training, and must be physically capable of performing the work of the trade. The apprentice must work standard operating engineers' hours in the plant at a gradually increasing rate of pay and, upon completing his apprenticeship, and being certified, he is advanced to operating engineer classification.

This certificate is by issuance of a certificate of completion by the Ohio Apprenticeship Council, bearing the Federal Committee on Apprenticeship seal, thus giving it national recognition. The IUOE also issues the diploma, which certifies satisfactory completion of the program.

Number of students in training varies from 75 to 125, depending on the conditions. This course of study has been carefully laid out by William H. Engelman. He has reduced all the standard principles, problems and their solutions, together with required factual data and handbook tables, to a large volume of mimeographed 8½-by-11-in. data sheets, which are given to the students. Their only expense is for textbooks, slide rules, steam tables, graph paper and similar supplies, and a nominal registration fee.

It is from this extensive and valuable notebook of fundamental power plant data that Mr. Engelman is supplying the material now being published in each issue of POWER GENERATION under the general title of Basic Power Plant Figuring.

All this adds up to one of the most effective power plant educational programs we have encountered. A young man works at the standard power plant operations during his shift and then studies the fundamental principles underlying them at night in the steam power plant engineering course.

The instructors are practicing engineers themselves, in close contact with the practical problems of operating the power, heating and water supply plants of the City of Cleveland. What could be more practical?

Fig. 2. (Right) Outline of subjects taught in Cleveland steam power plant engineering course

Subjects taught in the FOUR-YEAR CLASS ROOM STUDY COURSE consisting of 36 WEEKS at FOUR HOURS PER WEEK.	Any person employed in Power Plants, Refrigeration, Heating, Air-Conditioning, and Allied Fields is eligible to attend.			
Subjects	Year			
	1	2	3	4
1. Pract. Mathematics, formulas, areas, volumes.	48	16		
2. Types of steam boilers. A.S.M.E.& O.S. Code.	20	4		
3. Boiler mountings & details. A.S.M.E.& O.S.Code	20	4		
4. Pipes & fittings. Flow of steam and water.				12
5. Boiler furnaces, stokers, and fans.	8	8		8
6. Superheaters, Economizers, Waterwalls.		4	8	
7. Reciprocating and centrifugal pumps	12	12		
8. Heat, properties of water & steam, tables	8	8	4	16
9. Feedwater heaters and evaporators	4	8		4
10. Combustion, elements of coal burning	8		8	8
11. Combustion, elements of oil burning	4			4
12. Boiler fuels and boiler trials				24
13. Boiler management and inspection	8		8	4
14. Furnace efficiency and flue-gas analysis.		8	8	
15. Steam engines, valve gear & valve setting		20	8	
16. Steam turbines		4	8	16
17. Condensers and auxiliaries		12	8	
18. Power plant economics			12	4
19. Air compressors		4	4	
20. Heating, ventilating, & air-conditioning.				24
21. Feedwater and feedwater treatment	4		20	
22. Heat balance of a complete power plant				12
23. Lubricating systems.		8		
24. Flow diagrams.				8
25. Refrigeration.		24		
26. Electricity and electrical machinery			48	
Total hours per year	144	144	144	144

The subjects may not necessarily be given in the order listed above; they will be sufficiently flexible so as to be to the best advantage of the apprenticeship system.

Saturday afternoon and Sunday morning classes will also be held so that the student working on rotating shifts can always attend one class each week.

Students feeling the need of special assistance may attend these extra classes which will enable them to follow the general course much bettery it gives them a better understanding in the fundamental principles of Steam Power Plant Engineering and Allied Subjects.

This STEAM POWER PLANT ENGINEERING COURSE is given by:

The International Union of Operating Engineers, Local 589, Cleveland, O.
U.S. Department of Labor (Apprenticeship Section).
The OHIO State Board of Education.
The CLEVELAND Board of Education.

The Vocational Advisory Committee, 216 High St. Cleveland, O.

Fig. 3. (Below) Class dinner, Cleveland, June 22, attended by 75 members of course and guests, total 125 people

Toastmaster: Wm. Thomas, counsellor, IUOE. Principal speakers: Frank P. Converse, international vice-president, IUOE; Kenneth Nash, Cleveland Chamber of Commerce; R. O. Poole, U. S. Department of Labor; Chas. Gramling, international vice-president, IUOE; L. Freund, Superintendent, Cleveland Municipal Light & Power Plant; Chester R. Earle, managing editor, *Power Generation;* John Fintz, ass't sup't., Cleveland Board of Education; T. M. McComb, mechanical engineer, N.A.C.A.; D. C. Courtwright, sup't., Cleveland Trade School; Harold Ladd, chief eng. and sec'y, educational committee; Wm. H. Engelman, director, power plant course

Basic Power Plant

FIGURING

A Review for Old Timers—A Must for Young Timers

By **WILLIAM H. ENGELMAN,** Mechanical Engineer, Department of Water & Light, City of Cleveland, Ohio

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Physical Characteristics of Schedule 40 Pipe, Needed in Practical Power Plant Problems

All the standard physical data on Schedule 40 pipe, collected on these two pages from standard tables in many handbooks and data books

Saves looking them up in a number of different tables

KEEP THESE TABLES. You will need them in solving problems coming in future Basic Power Plant Figuring articles

Table A—DATA ON SCHEDULE 40 PIPE. (Formerly Known as Standard Pipe)

Nom. Pipe Size In.	Outs. Dia. In. O.D.	Inside Dia. In. D.	Wall Thick-ness In.	Area of Metal Sq. In.	Weight Per Foot Lb.	Cross-Sectional Internal Area		Square Feet of Surface Per Linear Foot		Linear Foot Per Sq. Ft. of Surface		Capacity in G.P.M. at 1 Ft./Sec. Velocity	Lbs. Water Per Hour, at 62.4# Cu.Ft. Vel.=1 F.P.S.	Nom. Pipe Size In.
						Square Inches	Square Feet	Outs.	Ins.	Ext.	Int.			
	1	2	3	A 4	5	6	7	8	9	10	11	12	13	
1/8	0.405	0.269	0.068	0.072	0.25	0.05683	0.000395	0.106	0.070	9.431	14.199	0.17713	88.65	1/8
1/4	0.540	0.364	0.088	0.125	0.43	0.10406	0.000723	0.141	0.095	7.073	10.493	0.32434	162.33	1/4
3/8	0.675	0.493	0.091	0.167	0.57	0.19089	0.001326	0.177	0.129	5.658	7.748	0.59498	297.79	3/8
1/2	0.840	0.622	0.109	0.250	0.85	0.30386	0.002110	0.220	0.163	4.547	6.141	0.94710	474.02	1/2
3/4	1.050	0.824	0.113	0.333	1.13	0.53327	0.003703	0.275	0.216	3.637	4.635	1.66214	831.90	3/4
1	1.315	1.049	0.133	0.494	1.68	0.86425	0.006002	0.344	0.275	2.904	3.641	2.69377	1348.23	1
1 1/4	1.660	1.380	0.140	0.669	2.28	1.49571	0.010387	0.435	0.362	2.301	2.768	4.66195	2333.31	1 1/4
1 1/2	1.900	1.610	0.145	0.800	2.72	2.03583	0.014138	0.498	0.422	2.010	2.372	6.34544	3175.90	1 1/2
2	2.375	2.067	0.154	1.075	3.66	3.35560	0.023303	0.622	0.542	1.608	1.847	10.45901	5234.74	2
2 1/2	2.875	2.469	0.203	1.704	5.80	4.78780	0.033249	0.753	0.647	1.328	1.547	14.92301	7469.00	2 1/2
3	3.500	3.068	0.216	2.228	7.58	7.39266	0.051338	0.917	0.804	1.091	1.245	23.04206	11533.00	3
3 1/2	4.000	3.548	0.226	2.680	9.11	9.88683	0.068659	1.047	0.930	0.954	1.076	30.81610	15423.00	3 1/2
4	4.500	4.026	0.237	3.173	10.80	12.7303	0.088405	1.178	1.055	0.848	0.948	39.6789	19859.00	4
5	5.563	5.047	0.258	4.304	14.62	20.0058	0.138929	1.456	1.322	0.686	0.756	62.3557	31209.00	5
6	6.625	6.065	0.280	5.584	18.97	28.8903	0.200627	1.734	1.590	0.576	0.630	90.0477	45070.00	6
8	8.625	7.981	0.322	8.400	28.55	50.0270	0.347410	2.258	2.090	0.443	0.478	155.9283	78042.00	8
10	10.75	10.020	0.365	11.91	40.48	78.8543	0.547601	2.817	2.623	0.355	0.382	245.7796	123013.00	10
12	12.75	11.938	0.406	15.77	53.60	111.9317	0.777303	3.340	3.13	0.299	0.320	348.8780	174614.00	12
14	14.0	13.126	0.437	18.64	63.30	135.3177	0.939706	3.665	3.44	0.273	0.291	421.7694	211096.00	14
16	16.0	15.000	0.500	24.35	82.80	176.7146	1.227185	4.189	3.93	0.239	0.254	550.7987	275675.00	16
18	18.0	16.876	0.563	30.85	105	223.6809	1.553340	4.712	4.42	0.212	0.226	697.1872	348942.00	18
20	20.0	18.814	0.593	36.15	125	278.0047	1.930588	5.236	4.93	0.191	0.203	866.5081	433687.00	20
24	24.0	22.626	0.687	50.30	171	402.0735	2.792177	6.283	5.92	0.159	0.169	1253.2161	627235.00	24

Pipes by "schedule numbers" introduced as tentative in 1935. Approved and adopted in 1939 by the Am. St'ds. Association (ASA-B36.10). Pipe up to 12 in. dia. inclusive is designated by its nominal inside diameter (D) while pipe 14 in. and larger is designated by its outside diameter (O.D.)

Wall thicknesses of 10 in. pipe and under are identical with those of standard weight pipe in former lists.

Designation of pipe wall by "schedule numbers" make the terms of "standard," "extra strong," and "double extra strong" obsolete.

Schedule number $= 1000 \times \frac{P}{S}$ when: P = internal pressure, psig. S = allowable fibre stress, psi.

Decimal thicknesses for the steel pipe sizes represent their nominal average wall dimensions and include an allowance for mill tolerance of 12.5 per cent under the nominal thicknesses.

The inside diameter functions of wrought iron pipe differ from the values for steel pipe given in this table, but the differences are well within the tolerances permitted with both kinds of pipe. In ordering always state: "Genuine" or "Guaranteed" wr. iron pipe.

EXPLANATION AND USE OF VALUES IN THE TABLE.

7. Area in square feet is also volume in cubic feet per foot length.
8. The value in square feet of outside surface per foot is also circumference in feet and square feet of heating surface.
12. For any other velocity multiply the G.P.M. in the table by the velocity factor.
13. Discharge capacity in pounds of water per hour at 1 ft./sec. velocity is based on 62.4 lbs. per cu. ft. (density at 52°F.) One cu. ft. water = 7.4805 gal.; one gal. = 0.1337 cu. ft. = 8.34 lbs.

HERE THE AUTHOR presents one of the most unusual and helpful tables of pipe data we have seen, covering many of the physical dimensions and characteristics of Schedule 40 pipe, ASA-B36.10. Next time he will offer a similar table for Schedule 80 pipe. These are the two you have most use for in 90 per cent of your power plant work, especially in industrial power plants.

For solving various practical problems in steam engineering, you need all the dimensions of pipe, columns 1 to 11. For calculating steam and water flows and velocities by various standard formulas, you need columns 12 to 16 and often 22 and 23. When you use pipe for structural purposes, then you need columns 17 to 21. Handy and practical for pipe layout man, as well as pipefitter, is column 25.

These articles on Basic Power Plant Figuring began in the February 1949 issue and will continue in each future issue. They are selected from the fundamental data and problem sheets used by Mr. Engelman in teaching his course in steam power plant engineering in Cleveland, Ohio. (See POWER GENERATION, Feb., 1949, page 82; and this issue, page 70). As soon as both pipe tables are published, we will present some of the author's sheets on design of piping, figuring practical boiler, turbine, condenser and pumping problems, heat balance and so on. In these, you will be referred back to these pipe tables for data, so SAVE THEM NOW—in file or notebook.

You should also save the full-size Mollier charts and tables of engineering data and conversion factors published in the first five installments, for future articles will refer back to them also.

Next time: Similar tables covering Schedule 80 pipe

Table A—DATA ON SCHEDULE 40 PIPE (Continued)

Nom. Pipe Size In.	Linear Feet to Hold		Lb. Wat. Per Lin. Ft. at 62.4# Per Cu. Ft.	Pipe Column at 15,000 Psi.		Elements of Pipe			Internal Diameter to the		Allow. Press. at 650 F	Thr'd for Tight Joint	Nom. Pipe Size In.
	One Cubic Ft.	One Gallon		Maximum Load, Lb.	Length Feet	Moment of Inertia	Section Modulus	Radius of Gyr'n. Squared	5.0 Power $= D^{5.0}$	2.5 Power $= D^{2.5}$			
	14	15	16	17	18	19	20	$\frac{=}{R^2}$ 21	22	23	24	25	
1/8	2531.60	338.730	0.0246	1080	0.6	0.00106	0.00530	0.01480	0.00141	0.03753		1/4	1/8
1/4	1383.13	184.990	0.0451	1875	0.8	0.00331	0.01230	0.02651	0.00693	0.07994		5/16	1/4
3/8	754.42	100.843	0.0827	2500	1.0	0.00730	0.02160	0.04367	0.02912	0.17065		3/8	3/8
1/2	473.93	63.352	0.1317	3750	1.2	0.01710	0.04070	0.06830	0.09310	0.30512	998	1/2	1/2
3/4	270 05	36.098	0.2311	5000	1.6	0.03704	0.07055	0.11130	0.37987	0.61634	900	1/2	3/4
1	166.61	22.274	0.3745	7410	2.0	0.08734	0.1328	0.17690	1.2702	1.1270	970	9/16	1
1 1/4	96.2742	12.8702	0.6481	10040	2.3	0.1947	0.2346	0.2913	5.005	2.2372	666	5/8	1 1/4
1 1/2	70.7314	9.4556	0.8822	12000	2.7	0.3099	0.3262	0.3876	10.818	3.2890	628	5/8	1 1/2
2	42.9129	5.7367	1.4541	16125	3.4	0.6657	0.5606	0.6196	37.731	6.1426	566	3/4	2
2 1/2	30.0761	4.0206	2.0747	25560	4.2	1.530	1.046	0.8976	91.750	9.5786	750	13/16	2 1/2
3	19.4788	2.6039	3.2035	33420	5.0	3.017	1.724	1.354	271.816	16.4871	680	1	3
3 1/2	14.5647	1.9470	4.2843	40200	6.0	4.788	2.394	1.787	562.235	23.7112	640	1 1/16	3 1/2
4	11.3116	1.5121	5.517	47600	7.2	7.23	3.214	2.279	1057.76	32.52	610	1 1/8	4
5	7.1979	0.9622	8.669	64600	9.0	15.16	5.451	3.526	3274.65	57.23	556	1 5/16	5
6	4.9844	0.6663	12.519	83800	11.0	28.14	8.50	5.04	8206.43	90.59	524	1 1/4	6
8	2.8784	0.3848	21.678	126000	14.0	72.50	16.81	8.63	32381.0	179.95	484	1 3/8	8
10	1.8262	0.2441	34.170	179000	18.0	160.70	29.90	13.50	101003	317.81	455	1 1/2	10
12	1.2865	0.1720	48.504	237000	21.0	300.30	47.10	19.07	242470	492.41	432	1 5/8	12
14	1.0642	0.14226	58.638			429	61.3	23.02	389639	624.21	426		14
16	0.8144	0.10893	76.576			732	91.5	30.06	759376	871.42	450		16
18	0.6438	0.08606	96.928			1177	130.9	38.10	1368825	1170.0	455		18
20	0.5180	0.06924	120.469			1704	170.4	47.12	2357245	1535.3	410		20
24	0.3581	0.04788	174.232			3422	285.2	68.00	5929790	2435.1	420		24

EXPLANATION AND USE OF VALUES IN TABLE

19. Moment of inertia $=$ $0.0491\ (\overline{O.D}^4 - D^4) = AR^2 =$ item 4 $\times$ item 21.

20. Section modulus $\times$ fiber stress $=$ bending moment M_B.

23. Values of inside pipe diameters to the 2.5 power are the direct ratios of their relative discharge capacities. Do not use area only for comparing carrying capacities, it is misleading and wrong. See the example:

How many 2 in. pipes are req'd. to equal the discharge of a 5 in. pipe? $5.047^{2.5} = 57.23$; $2.067^{2.5} = 6.1426$ (from table)
$57.23 \div 6.1426 = 9.3$—2 in. pipes to equal one 5 in. pipe in flow.
$20.006 \div 3.356 = 6$—2 in. pipes to equal one 5 in. pipe in area.

24. Allowable working pressure at 650°F. for grade "A" seamless steel piping, A.S.T.M. specification A-106, covering power piping and district heating systems. The minimum ultimate strength in tension is 48,000 psi., which gives a working strength of 9,600 psi. at 650°F., the base for the tabular values. For lower steam temperatures, values listed for 650°F. must be used. For grade "B" seamless steel piping multiply values in table by 1.25, since Grade "B" is slightly stronger than Grade "A."

General practice limits the use of schedule 40 pipe to a steam pressure of 400 psig. at 650°F.

For steam pressures over 400 psig. use schedule pipe to suit steam condition.

For water and other liquids at temperatures below 250°F. and non-shock, use values given in Col. 24.

A POWER GENERATION FEATURE

A Practical Thermoelectric Generator

Thermal efficiency of modern steam generating systems . . . Limitations of systems in use today . . . Quest for more direct methods of converting fuel energy into power . . . The Peltier Effect . . . The thermodynamics of electrical phenomena . . . The Fitterer Thermocouple — its construction and use in the steel industry . . . Proposed thermoelectric generator — its theory and practical construction

By **CURTISS D. BASSETT,**

Consulting Engineer, Ann Arbor, Michigan

MODERN CENTRAL STATION steam generators in order to produce cheap electrical power in the face of rising costs operate at extremely high pressures and temperatures. The resulting increased thermal efficiency of the operating steam cycle is achieved therefore through the use of tremendously complicated equipment safeguarded at a thousand and one different places to protect operating personnel and the equipment from the obvious danger of steam under enormous pressure and red hot temperature.

This fundamentally simple thermodynamic trick for increasing the thermal efficiency of an operating cycle, viz. raising the temperature at which heat is added to the working medium, is familiar to most engineers. Practically, as most engineers know, it is not so simple to perform. The fact that steam generators and the turbines they drive can operate at all at red heat is little short of an engineering miracle achieved from the endless labor of countless minds over countless hours.

The sixty-four dollar question is, of course, when and how can we go to still higher steam temperatures and pressures? Can we imagine a steam generator, for instance, operating at 2700 F, or at 4500 F? Obviously not; only with the greatest difficulty have we been able to develop metals capable of withstanding temperatures of slightly above 1000 F, at the very high steam pressures in use.

These metallurgical limitations have led many engineers in the field of power engineering to wonder whether there might not be some other way to convert the heat energy in fuels into electrical energy. Many years ago Walter Nernst, the noted German physicist proposed to transfer the energy of coal, by treatment in a blast furnace, to iron or zinc and then utilize these elements as galvanic elements to generate electricity. An investigator named Baur in Zurich patented a *gas* battery in which one of the electrodes was a stream of gas in process of combustion.[1]

Other schemes involved the use of thermocouple piles but none of the ideas ever materialized into practical systems. The thermocouple scheme seems simple enough, but the potential developed by the conventional

[1] Electricity from coal. Steam and Gas Turbines, Stodola translated by Louis Loewenstein. Page 1306, Volume 2. McGraw-Hill Book Co., 1927.

It is not often that a technical publication is privileged to present an idea as important and as revolutionary as this one by Mr. Bassett. Ever since the development of the steam engine, men have wondered whether it might not be possible to convert the energy in fuel directly into electrical energy without the use of boilers, turbines and rotating electric generators. Various schemes have been tried but without success. As early as 1823 Seebeck discovered the thermoelectric effect, and many investigators tried to put that effect into use in a practical thermoelectric pile or generator. None of these attempts were successful because the emf produced by the ordinary thermocouple is so very small that no appreciable amount of power could be derived from such a pile. The thermoelectric effect has been used to a high degree but only in the field of temperature measurement.

Curiously enough, in the early 1930's a development occurred in the steel industry which seems to have had little effect elsewhere, yet, as indicated in this article, this development holds momentous implications in the power industry if it can be made to work. In short, it may make possible a practical thermoelectric generator capable of converting the heat energy in fuel into electrical energy with a thermal efficiency far greater than that possible by the best heat cycles in use today.

Mr. Bassett's ideas are set forth in this article. They are presented here for comment and discussion. Admittedly, no generator of this kind has ever been built and until one is built the validity of the idea can not be assured. The fact remains, however, that the thermocouple used in this generator is, and has been, in use in the steel industry for some fifteen years and its 300 microvolts per degree Centigrade is so far higher than the emf of any other thermocouple known that it is well worth considering as a method of generating electric power. At 1700 C (3092 F) it develops an emf of ½ volt.

Aside from its high electromotive force, the silicon carbide-carbon thermocouple is ideally suited for use in a furnace because of its superior characteristics as a refractory.

So, let us have your ideas on this proposal. There may be hidden obstacles which may forever prevent the idea from working. If so, it is the purpose of this article to bring them out. Careful search through the literature reveals little data or information on this subject.

This article presents the basic principles of the silicon carbide-carbon thermoelectrical generator. In another article in a subsequent issue Mr. Bassett will present the details of an actual large unit of this kind—one capable of generating thousands of kilowatts.

metallic thermocouple is so low—a few microvolts—that from a power standpoint it has been useless.

Recent years, however, has brought into light a new type of thermocouple one delivering much higher potentials than previously possible so that, today, it seems possible to build a thermoelectric generator capable of operating at temperatures of 3000 and 4000 F and, thus, eliminate the steam cycle entirely. Such a generator would, of course, have a correspondingly high thermal efficiency without the hazard of high pressure steam.

Before the details of this new thermoelectric generator are presented, it may be helpful, to consider, briefly, the history of the thermoelectric effect.

In 1823 Seebeck discovered that if in a closed circuit of two metals (a thermocouple) the two junctions are maintained at different temperatures, a steady electric current will flow. He is further credited with noting that the thermal emf which caused this current to flow was proportional to the temperature difference between the two junctions, and a function also, of the materials making the couple.

In 1834 Peltier had determined the fact that when electricity is caused to flow across a junction of two dissimilar metals in one direction, heat is absorbed and the junction cooled. When the current is reversed, the junction is heated.

In 1853 Icilius published the results of his experiments with the Peltier effect in which he found that the rate at which heat is absorbed or evolved at a junction of two dissimilar metals is proportional to the current, i.e.

$$(1)\quad Q = \pi I \qquad \text{(Ref. 7)}$$

Where π is the Peltier coefficient or heat absorbed when unit quantity of electricity traverses a junction.

In a series of papers published between 1851 and 1854 Sir William Thomson (Lord Kelvin) described a further thermoelectric phenomena associated with Seebeck's thermocouple and arising from the temperature gradient in the conductors between the hot and cold junctions. A temperature gradient in a conductor is accompanied by a small voltage gradient whose magnitude and direction depend upon the particular material; and further when a current flows, there is an evolution or absorption of heat due to the pressure of the gradient. This is known as Thompson heat,

$$(2)\quad Q_t = \zeta I \Delta T \qquad \text{(Ref. 7)}$$

where ζ is the Thomson coefficient and ΔT the temperature gradient.

The above historical discoveries were first put to practical use in temperature measuring instruments employing Seebeck's thermocouple. In fact so familiar is this use that when we speak of a thermocouple, we automatically think of a thermometer assigning no further significance to the name.

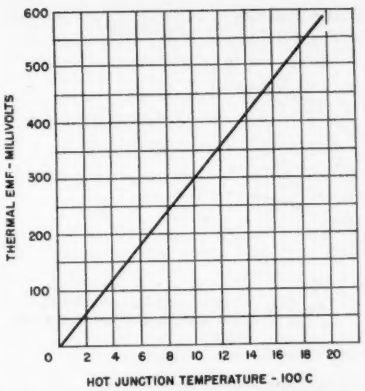


Fig. 1 Hot junction temperature—Thermal Emf relationship of the graphite-silicon carbide thermocouple
(Cold junction temperature constant at 18 C.) Ref. 1

However during the 1930's three significant contributions were made to our knowledge of thermocouples which, when taken together and understood, make it an engineering mechanism of importance, particularly in the field of electric power generation.

In 1933 G. R. Fitterer described (Ref. 1) his investigations with refractory materials having thermoelectric properties. One class of couples considered was that in which carbon and a carbide were thermo elements, and from this class came the rugged graphite-silicon carbide couple which has been in use in the steel industry for many years (Ref. 2, 3).

Engineering-wise Fitterer's contribution was many sided. For the first time materials which could be considered engineering materials were employed successfully in a thermocouple. This lifted the thermocouple out of the platinum class. In addition this thermocouple could produce significant voltage. This lifted the thermocouple out of the microvolt class.

In 1934 P. W. Bridgman after a series of exact laboratory measurements with all sorts of metallic thermocouples and other thermoelectric mechanisms published his results in one understandable volume (Ref. 4). An engineer reading this work, if nothing else, is made aware of the fact that the laws of thermodynamics, which he studied in college, govern and may be used to interpret any thermoelectric phenomena.

Finally in 1938 Edwin H. Hall (Ref. 5) definitely established that an electric current flowing in a thermocouple operates on the Carnot cycle. It absorbs heat isothermally at the hot junction. It evolves heat isothermally at the cold junction. In the conductors, neglecting the Thomson effect, the current flows adiabatically, ie. heat is neither added nor removed. Electricity, rather than steam or air, is the working medium.

With this in mind, the efficiency of the thermoelectric Carnot cycle,

$$(3)\quad \eta = \frac{T_1 - T_2}{T_1}$$

where T_1 is the absolute temperature of the hot junction and T_2 the absolute temperature of the cold junction, using a Fitterer thermocouple can far surpass that of any other working cycle in use today.

The Fitterer Thermocouple

The characteristic of a thermocouple is the thermal emf vs hot junction temperature curve. This curve for the Fitterer thermocouple (Ref. 1) is a straight line.

$$(3)\quad E = 0.301t - 15.05$$

where E is in millivolts and "t" is in degrees Centigrade, and this relation holds up to 2000 C at least, which is the highest published temperature at which it has been used (Ref. 2). See Fig. 1.

The thermo electric power "P" of a thermocouple is the slope or first derivative of the characteristic curve, in this case a constant.

$$(4)\quad P = \frac{dE}{dt} = 0.301 \text{ millivolt per}$$

degree Centigrade.
In other words "P" is the incremental increase in thermal emf caused by an increase of one degree Centigrade in the temperature of the hot junction.

This quantity "P" is used to determine the value of the Peltier coefficient (Equation 1) by the relation:

$$(5)\quad \pi = PT \qquad \text{(Ref. 7)}$$

where "T" is in degrees Centigrade absolute. Equation 1 now becomes:

$$(6)\quad Q = PTI.$$

This is an expression for the heat

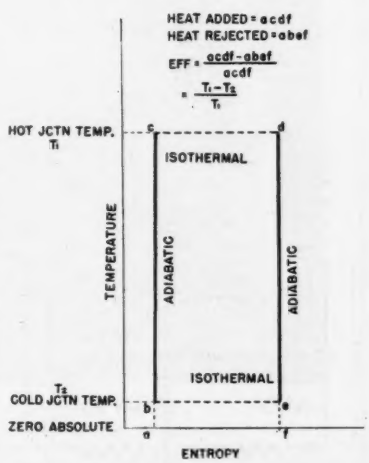


Fig. 2 The temperature-Entropy Diagram of an electric current flowing in a thermocouple circuit

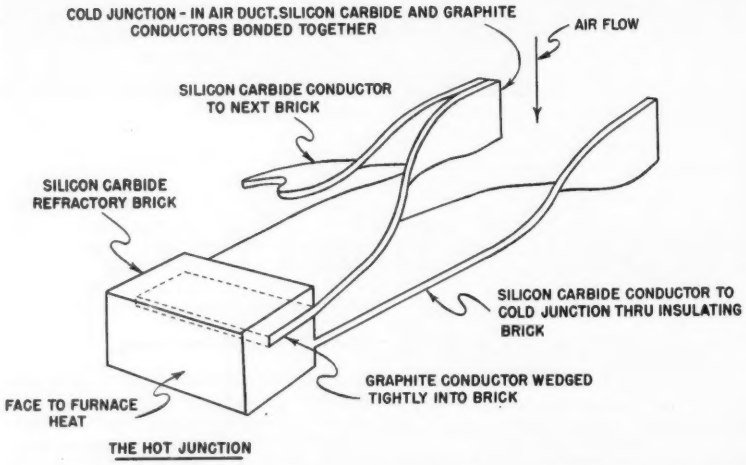

COLD JUNCTION - IN AIR DUCT, SILICON CARBIDE AND GRAPHITE CONDUCTORS BONDED TOGETHER
AIR FLOW
SILICON CARBIDE CONDUCTOR TO NEXT BRICK
SILICON CARBIDE REFRACTORY BRICK
SILICON CARBIDE CONDUCTOR TO COLD JUNCTION THRU INSULATING BRICK
GRAPHITE CONDUCTOR WEDGED TIGHTLY INTO BRICK
FACE TO FURNACE HEAT
THE HOT JUNCTION

Fig. 3 Typical hot and cold junction for a thermoelectric generating furnace using conventional fuels

transferred from hot junction to cold.

The second derivative of the characteristic of a thermocouple is used to calculate the Thomson coefficient of Equation 2 as follows:

$$(7)\quad T\frac{\zeta^2 E}{\zeta t^2} = -(\zeta_x - \zeta_y).$$

(Ref. 7)

For the Fitterer thermocouple this quantity is zero which indicates the equality of the coefficients for both graphite and silicon carbide. Ref. 6 lists no Thomson coefficient for either material of the purity required in a thermocouple; however graphite most certainly does have a Thomson coefficient, and from Equation 7 we may assume that the silicon carbide does also.

Figure 2 presents the typical temperature—entropy diagram of any thermocouple. If we assume that it is a graphite-silicon carbide thermocouple with hot junction placed as a refractory brick in a furnace fired with conventional fuel and, further, that it operates at an equilibrium temperature of 2700 F, the cycle efficiency, from Equation (3.), is 82.2 per cent.

If we assume that the hot junction is placed as a moderator brick in a nuclear reactor and operates at an equilibrium temperature of 4500 F, probably the highest safe temperature for silicon-carbide (Ref. 6), the Carnot cycle efficiency is 88 per cent. In each case the cold junction temperature was taken at 100 F.

Compare this with the Rankine cycle efficiency of the most modern high pressure, high temperature steam generator and turbine operating at, for instance, 1380 psi, 935 F, and condensing at 3 in. Hg. This is 32 per cent.

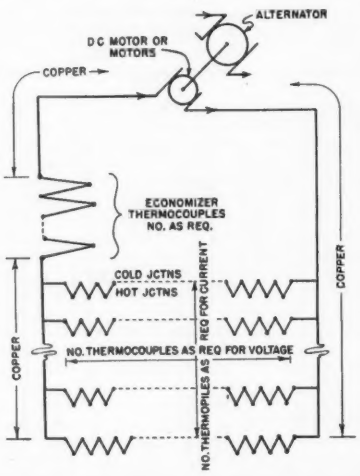


Fig. 4 The circuit of the thermoelectric generator and load

The Proposed Thermoelectric Generator

The proposed generator would consist of a circuit (Fig. 4) of graphite-silicon carbide thermopiles hooked in parallel and placed around a source of heat, for instance a furnace fired by conventional fuels (Fig. 5), such that the hot junctions are presented to the heat and the cold junctions are on the outside, so that they may be readily cooled.

Physically each brick in the refractory wall of the furnace would be a hot junction (Fig. 3) which is connected through the insulating brick by two conductors, one graphite and one silicon carbide, to a cold junction (Fig. 3), the cold junction being in the air space between the insulating brick wall and the casing. This air space would be in reality a large air duct surrounding the furnace through which the air for fuel combustion would flow to the plenum chamber. In so flowing it would cool the cold junctions, carrying the heat evolved therefrom back into the furnace.

In such a physical setup, therefore, gain in economy is twofold. Not only is the working cycle more efficient, but also the heat rejected at the cold junction is used regeneratively. Actually of course to keep the cold junctions at the required temperature may require more cooling air than can be used for combustion in which case the excess can be bled off from the plenum chamber. The point is, however, that not all the heat rejected at the cold junctions is lost.

Only such a number of thermocouples would be connected in series (a thermopile) that their collective voltages would add up to the desired load DC voltage. All thermopiles would be connected in parallel, their number being governed by the required current. In other words, each thermopile would generate only part of the total current but the full voltage.

The total current, in turn, would be determined by the load required and the full voltage. Then the total circuit resistance, including load, lines, and generator would be determined from the maximum current and voltage requirements. The resistance of the generator itself, of course, should be kept small, causing not over 2 or 3 per cent power loss.

Figure 4 shows a series of economizer thermocouples connected in series with the bus. In the furnace the hot junctions (Fig. 6) would be placed across the width of the furnace and directly in the path of the hot gases expanding toward the breeching. The required number of these giant thermocouples would be determined by the desired temperature of the gases entering the stack.

The full bus current would cross each hot junction, thus removing a maximum amount of heat from each (See Equation 6.), The purpose of these economizer thermocouples is merely to be a series of electrical heat exchangers. Since their hot junctions would operate at successively lower temperatures, their collective power generating efficiency would not be as impressive as that of the thermopiles in the furnace refractory wall.

It was mentioned above that each thermopile would generate only part of the required current. The number of piles required would therefore be the total current divided by the increment of the total assigned to each pile. This increment of current is, in turn, determined by the desired size of the individual thermocouple. Both graphite and silicon-carbide have a definite electrical resistivity (Ref. 6). Knowing the resistivity and the desired size of each thermocouple, the resistance first of one couple and hence of the thermopile may be calculated. Knowing further that the I^2R loss in the generator must be kept at, say 3 per cent of the total power, the current per thermopile can then be solved.

The area of each hot junction presented to the interior of the furnace must be such that it can absorb heat to, first, generate its part of the thermopile current and, second, furnish the heat rejected at the cold

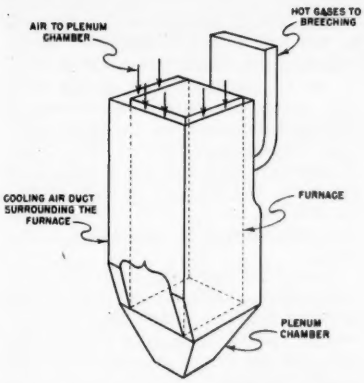


Fig. 5 The furnace and cooling air duct

junction. The first item is determined by the heat equivalent of electricity, viz. 3412 Btu per hour equals one kilowatt. The second item is determined from, first, Equation 6 which is the expression for Peltier heat absorbed by a current crossing a hot junction and, second, by the heat traversing by thermal conduction from hot junction to cold.

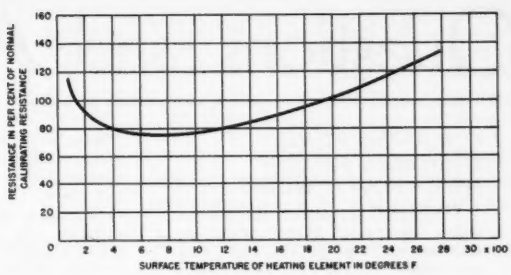
In closing, detailed data of the physical and electrical properties of both graphite and silicon carbide, particularly the latter, are far from complete. For use in a thermocouple these materials must be quite pure; and while Ref. 6 carries some information of use, much of it is applicable only to the above materials in more or less impure composition from the standpoint of the use described herein.

Just how the Thomson effect will change the appearance of the temperature-entropy diagram cannot be calculated at present since, as mentioned above, no reliable data exists on the Thomson coefficient for either material.

It is quite possible that there are or will be other refractory materials with desirable thermo electric properties which could be used in place of silicon carbide. The most desirable properties of such a material are good thermal and electrical conductivity and a thermo electric power in combination with graphite superior to that of silicon carbide (Fig. 1). Research on thermoelectric materials for power generation has been practically non-existent.

With respect to the electrical resistivity of silicon carbide the curve shown in Fig. 7 is extremely interesting. This gives the electrical resistivity of silicon carbide as made up into "Globar" heating elements, over the range of temperature these elements operate. In this curve, 100 per cent represents the resistance at the standard calibration temperature of 1960 F. The resistivity of the material at this temperature is 0.0394 ohms per inch cube. Thus, the per cent scale in this curve can be converted into resistivity simply by multiplying that figure by the ordinate of the curve at any given temperature.

Fig. 7 Curve showing the variation in resistance with temperature of silicon carbide. (Curve furnished by The Carborundum Co.)



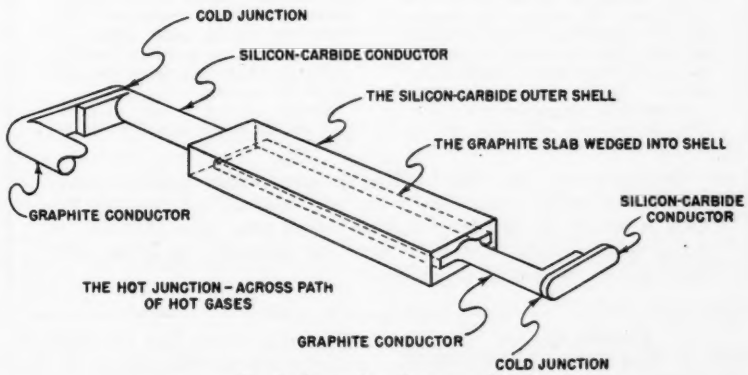


Fig. 6 Economizer thermocouple

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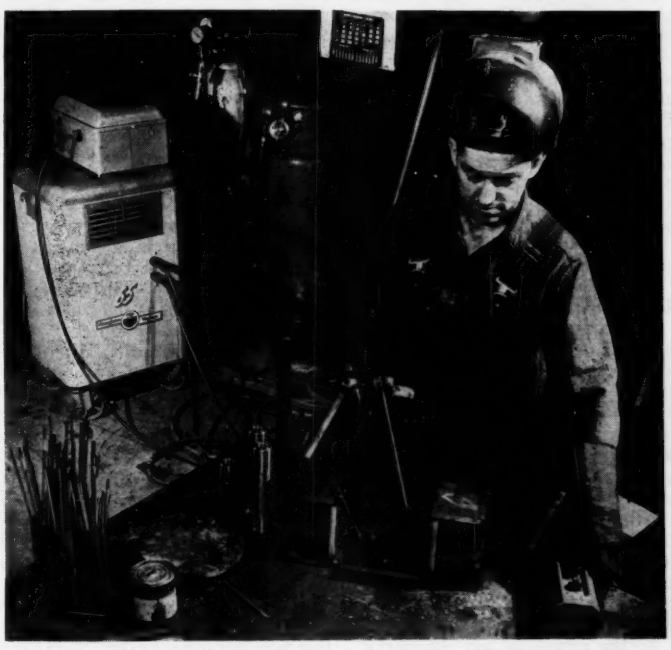


A remote control unit for use with the Westinghouse "65" line of a-c welders permits the operator to change the current setting and thereby adjust the arc without walking back to the machine. The operator simply presses either the "Raise" or "Lower" pushbutton on the small portable station and a small motor moves the core, making the necessary adjustment. The remote control is easily installed by connection on primary terminals of welding transformer

Questions and Answers

Q & A—THE POWER ENGINEER'S FORUM—HERE'S HOW IT WORKS

YOU HAVE a question about some detail of power plant operation, maintenance, design. You can't find the answer in your own experience nor in the books. So you write in to our editors. If we know the answer, we send it right back to you. (Maybe we don't know the answer either, but we usually know where to get it for you.)

In any case, we publish your question, signed only with your initials. We do not reveal your identity.

Dozens of engineers write in to us, giving their answers. We forward you copies of the replies as soon as we get them.

You, too, co-operate with other engineers by answering their published questions in the same way.

Then, so far as space permits, we publish those replies as soon as possible, so that everybody will learn what the others know about the problem. We pay well for all answers published. And those who answer get credit for knowing.

Simple, isn't it? And effective? Just ask the power engineer who has tried it!

Engineers who take the trouble to answer your question would appreciate some information from you, transmitted through the Q & A editor, on how their answers helped solve your problem. In doing this, indicate whether or not your comments could be published for the benefit of all readers.

Question No. 446

WHY IS THIS CIRCUIT GROUNDED THROUGH A FUSE?

WILL Q & A readers clear up a problem that is puzzling me?

In our plant we have a 220-v, 60-cycle, 3-phase circuit for power. Voltmeter readings show: L1 to ground box, 220 v; L3 to ground box 220 v; L2 is grounded and registers 0 v; L1 to L2 and L2 to L3 each read 220 v.

L2 is grounded through a fuse. Why is this done? What is the correct amperage for fusing? Could such a line be solid throughout?

Baltimore, Md. W.T.C.

Editor's Note:—Judging from W. T. C.'s data, it is safe to assume he has a 3-phase, 3-wire distribution system with no neutral wire. We have given him our ideas about grounding such a system, but readers' comments would be appreciated.

Question No. 447

WHY DID MOTOR ROTOR OPERATE OFF CENTER?

I AM A MACHINIST in a power house for the Navy. This week we received three new motors for our feed pumps. Each motor is rated at 2700 v, 60 amp, 300 hp, 3550 rpm.

I had the job of setting them up. The first new motor I set up acted in the following way:

The rotor had a "float" of 3/8 in. Before the coupling was made up, the electrician connected the motor and checked it for rotation; and when he was doing this, I noticed that the rotor shot away over to the end away from the pump. Well, I made up the coupling and when the electrician put in the switch, the rotor started and went over hard the opposite way toward the pump end. I had 1/8 in. between hubs when the rotor was hard up to the pump end.

What I want to know is: Why didn't that rotor find its magnetic center somewhere in that 3/8 in. float space?

We ran the motor for 24 hours and it ran hot. Temperature at the bottom of the bearings outside was 155 F, at the fields 180 F, after a run of 3 hours. The rotor in the meantime had gone hard up against the face of the pump end bearing. We finally had to shut it down. The other two motors were all right and did not act in this way.

Where was the magnetic center of that first motor? Should the magnetic center be the same with a load as without a load? There is quite a debate about this here at the plant.

Hicksville, N. Y. P. M.

Question No. 448

WHAT MAKES TURBINE NO. 2 DROP LOAD AND LOSE VACUUM?

IN OUR INDUSTRIAL power plant, there are two turbine generators of 750 kw rated capacity each and one of 500 kw capacity. The plant is also connected to and synchronized with the power company line.

Turbine No. 1, of 750 kw rated capacity, is connected to a 2400-sq ft surface condenser and will carry its rated load with 165 psi inlet steam pressure and 27 in. vacuum, with condensing water at 85 F.

Turbine No. 2, also of 750 kw rated capacity, is connected to two 1700-sq ft surface condensers, mounted at the same level and with the exhaust equally divided between the two by a 24-in. Y. This Y is bolted to an expansion joint below the exhaust nozzle and connected to the two condensers by 24-in. pipes.

The two condensers of No. 2 have ample cooling water at 85 F, with separate discharge pipes, and are connected to the same two-stage steam jet air ejector and condensate pump.

This No. 2 turbine will carry up to 500 kw with 145 psi inlet steam pressure and maintain continuously 27 in. of vacuum. But if the load and inlet pressure are increased beyond this point, the vacuum gradually drops and finally, with 23 in. of vacuum and 165 psi inlet steam pressure, the turbine is only carrying 400 kw, an extremely uneconomical condition that cannot be tolerated.

This turbine has, with its two condensers, 1000 sq ft more condensing surface than No. 1. Why will it not carry a load of 750 kw, with 165 psi steam pressure, without losing vacuum?

The blading has been examined and found in good condition and perfectly clean, and there are no air leaks in the vacuum system. The discharge cooling water does not increase appreciably in temperature when inlet pressure increases, although, of course, the pipe to the air ejectors gets hotter, corresponding to the lower vacuum.

It is desired to reduce purchased power as much as possible, and an increase of 500 kw in factory load is expected in the course of a few months; consequently it would be very desirable to get No. 2 to carry its rated load without loss in vacuum. But what can be done to obtain this?

Ciudad Trujillo L.R.D.
Republica Dominicana

Answer No. 440

HOW CAN HE COMPARE SIMPLEX AND DUPLEX PUMP EFFICIENCIES?

TO ANSWER this question properly, it would be necessary to know the particular service for which this pump is needed; also whether he is considering direct-acting steam pumps or power-driven pumps. Assuming that direct-acting steam pumps are meant, the following points should be considered in comparing simplex and duplex types. The duplex pump can be fundamentally regarded as two simplex pumps connected and timed, by means of their valve gears, to operate in series, with strokes slightly overlapping—that is, one begins its stroke a little before the other ends its stroke.

The advantages of the two types can be briefly summarized as follows:

Simplex: Slightly better steam economy, mechanical and volumetric efficiency, fewer moving parts and packings to be maintained and replaced, lower first cost, less weight and space.

Duplex: More even discharge flow, less likely to stall.

Of course, the actual service would probably be the deciding factor. It would be interesting to hear from some engineers who have had experience with both types.

Philadelphia, Pa. WILLIAM B. ROBINS

Answer No. 441

WHO CAN HELP THIS ENGINEER PUMP COLD MOLASSES?

EDITOR'S NOTE:—Our heartiest thanks to two readers, who have put us on a hot trail leading to some practical information on pumping molasses. You'll see it as soon as we can get it into type.

One reader is our old friend Dan Gutleben, formerly plant engineer of Pennsylvania Sugar Co. but now retired after 24 years of service there (see A Good Engineer Steps Down, *Power Plant Engineering,* May, Nov., 1945). He lives now in California but continues his active life "gallivanting about the country," he says. Actually he is very busy compiling data for a monumental book on the history of the sugar industry and travels about visiting old friends and plants in the industry for that purpose. No slippers and arm-chair for Dan—he'll prolong his interesting life at least 50 per cent by his activity. His "Dear Harry" letter every year (many pages of news about the sugar industry, sent to several hundred "sugar tramps" throughout the world) is itself a book, informative, interesting and welcomed by everybody who receives it.

"I have pumped many millions of gallons of molasses," says Mr. Gutleben. "We used to get shiploads of it from Cuba and consumed a little over a million gallons a month. Another company, a couple of miles below us, used two or three times that much and I was familiar with their plant. If V.L.G. could produce a vacuum of, say, 100 in. of mercury, he might be able to lift the molasses into the pump suction! The kind of molasses he mentions can't even be pumped from a shallow tank with the pump under it. The pump will push out anything that will flow into the cylinder."

He then tells us the best place he knows to get all the technical data on pumping molasses and we have sent for it.

The second reader, B. D. Titus, Engineering Dept., Skelly Oil Co., Eldorado, Kansas, also refers us to the same source of information as does Mr. Gutleben.

So there'll be more anor

Answer No. 442

HOW MUCH PHASE UNBALANCE CAN A GENERATOR STAND?

Not as Much as A.R.E. Has, Says von Dannenberg

THE MANUFACTURERS of a-c turbine generators involving field rotors of barrel-wound type do not recommend operating continuously at more than 10 per cent. Whether the unit under consideration may be able to operate continuously as reported cannot be determined except through actual operating experience or by referring the condition to the generator manufacturer.

The reason for or possibility of operating trouble is due to the unbalanced stator magnetic reaction which in turn causes eddy currents to flow in the rotor core; since this is designed as a generator to carry only magnetic flux so an actual current flow of a low valve may cause considerable heating which may eventually result in a mechanical failure.

It is possible to build generators to carry appreciable unbalanced line currents but the field rotor must have conducting sections, copper bars or equivalent means added in the generator rotor so its appearance will be like a squirrel cage type rotor of an induction motor or synchronous motor.

There are on record two instances, both for single phase railway loads where conducting elements had to be added to enable the units to carry their full load. The changes were most expensive.

One manufacturer has developed a series of curves to indicate the allowable unbalance in turbine generators. These are based upon the intersection of two coordinates, being the ratio of smallest to rated current and largest to rated current, being respectively 0.665 and 1.11 for the currents given in this question. Since the intersection falls outside of the permissible range, the maximum being 1.00 it should be assumed from this manufacturer's criterion that the operation at the unbalance given is not permissible. In any event it would be best to refer the situation to the manufacturer.

Brooklyn, C. O. VON DANNENBERG

Overload, Not Unbalance, Is the Villain of the Piece, Says Bourne

THE ONLY SURE way of telling if the unbalance will be detrimental to the machine in question is by a check on the temperature rise above ambient temperature.

A.R.E. states that the rated amperes per phase are 451 and that two phases are delivering 500 amp each and one phase 300 amp. With 2400 v between phases, this will give the machine an output of 1800 kva, which is 4 per cent below its rated capacity of 1875 kva. However, the heating effect of the I^2R losses will be slightly greater than at 1875 kva with a balanced load. In each of the overloaded phases, the I^2R heating effect will be 23 per cent greater and in the lightly-loaded phase it

"... and why not?—We get a lot of visitors."

will be 44 per cent less than would be the case with their rated 451 amp. This gives an average increase of about 1 per cent for the three phases.

This 1 per cent average increase is somewhat misleading. The armature iron of the cooler, underloaded phase will conduct some of the heat away from the overloaded phases but you will still have a hot-spot temperature increase of perhaps 15 per cent in the overloaded phases. Therefore, if the machine does not have a hot-spot temperature indicator, the over-all temperature rise should be held about 5 C below the rated rise of the machine.

If the same two ammeters always show the overload, it is in a single phase of the line wires and the prudent thing to do would be to reapportion the load so as to remove the overload on this phase.

Although an unbalanced condition is unfavorable to a proper power factor and wave form, the limiting factor is the effect on temperatures that the unbalance may cause. It would be entirely possible to run with a 100 per cent unbalance, or single phasing, but only to 58 per cent of rated kva. It is the overload and not the unbalance that is the villain in the plot.

Placerville, Calif. SYDNEY E. BOURNE

Answer No. 443

WITH PRESSURES HELD CONSTANT, HOW CAN YOU INCREASE REFRIGERATION?

No Practical Method, says Holman

IF AN AMMONIA compressor is operated at constant suction pressure, constant speed, constant discharge pressure, and the vapor enters the compressor in a saturated state, there is no practical method of increasing the capacity, except by reducing the superheat of the vapor during compression. This assumes that the suction strainer is clean, inlet and outlet passages unobstructed, and that machine valves open widely, freely and long enough to permit near-complete filling of the cylinder with vapor at suction line pressure on the suction stroke, and near complete evacuation of the cylinder on the discharge stroke. This further assumes a well-designed compressor in a good state of repair.

If at each stroke of its pistons the cylinders of an ammonia compressor fill with vapor slightly under the pressure prevailing in the evaporators, or suction line, and discharge of this vapor on the compression stroke is accomplished without raising its pressure or temperature very far above that prevailing in the condenser, capacity of the machine has been reached, and may be regarded as absolute for a constant speed machine. Although more or colder cylinder jacket water may remove slightly more superheat of the vapor, and lower very slightly the actual cross-machine compression ratio, the balance between adiabatic and isothermal compression is already fixed closely by the constant speed of the machine.

Determining factors in the compression of ammonia vapor, as they affect compression capacity, may be set forth as follows:

1. Suction line pressure, usually that indicated by gage.
2. Degree of vapor saturation.
3. Vapor pressure in cylinders at beginning of compression stroke.
4. Actual compression ratio (Nos. 5/3; not 6/1).
5. Actual discharge pressure, always above condenser pressure.
6. Condenser pressure, usually that indicated by gage.
7. Heat lost from vapor during compression.
8. Vapor lost through piston rings, leaky suction valves, etc., during compression.
9. Volume of clearance space.
10. Compressor speed.

Study of the above list will show that, if Nos. 1, 2, 4 and 6 are made constant by operating methods, 9 and 10 by machine design and 3 and 5 by machine design plus operating methods, there is little or no way to increase the capacity by increased heat transfer to jacket water (No. 7), or by reducing vapor slippage past rings and valves of a compressor maintained in good repair (No. 8).

Do not fall into the error of thinking, as some engineers have done, that increasing the flow of condensing water through the condenser, or using colder water, will do any good. Either of these procedures will at once reduce the discharge pressure and this is forbidden by the conditions of the problem.

However, there is one possibility, if it can be carried out:

If the liquid ammonia, after condensing, is passed through a coil submerged in water colder than the liquid, some heat is removed, and the quantity of the flash vapor formed, when cooling this liquid at the valve orifice, is thereby reduced. To maintain suction pressure, the expansion valve can be opened slightly wider and more refrigeration is produced. Net refrigeration gain is quantity of heat in Btu removed from the liquid by the water.

This refrigeration gain cannot be obtained with a heat-exchanger accumulator, for, in such a case, the heat remains in the refrigerant circuit to superheat and lower the quality of the vapor going to the compressor.

Reducing the capacity of an ammonia compressor is quite another matter, and may be accomplished in a variety of ways. Compressors are designed and built with extra stop valves which, when opened, by-pass a part of the vapor or start compression later than at the beginning of the stroke. The simplest and most widely used method of reducing the capacity of the conventional compressor is to partly close the manifold suction stop valve. Restricting the opening of the machine suction valves may be used to advantage.

Decatur, Illinois GEORGE HOLMAN

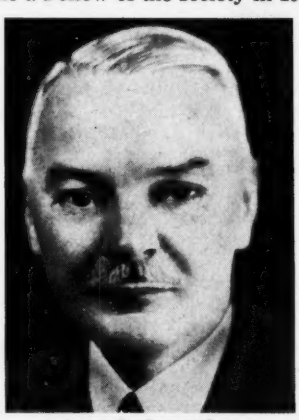
JAMES D. CUNNINGHAM, NOMINATED TO HEAD ASME

JAMES D. CUNNINGHAM, president of Republic Flow Meters Co., Chicago, is the 1950 nominee for president of The American Society of Mechanical Engineers. He heads a slate of new officers, including four regional vice presidents and two directors-at-large, submitted by the nominating committee during the society's semi-annual meeting at the University of California Extension Building in San Francisco, June 27-July 1. Since the committee presents only one name for each office, nomination is tantamount to election.

Formal election will take place in the Fall by letter ballot of the membership, which totals more than 25,000 engineers throughout the United States. Mr. Cunningham and the new slate of officers will begin their terms at the end of the ASME annual meeting in New York next December. Mr. Cunningham will succeed James M. Todd, consulting engineer of New Orleans.

Born in Chicago in 1887, Mr. Cunningham began his industrial career as a clerk for Armour Glue Works, after graduating from Hyde Park High School in 1905. He served as vice-president of the Clyde Machine Works Co. from 1909 until 1911 when he left to found and become president of the Steam Appliance Co., now Republic Flow Meters Co.

Mr. Cunningham is a member of the Western Society of Engineers, Illinois Manufacturers Association, and the Chicago, Union League, Commercial and Indian Hill Clubs. He has previously held office as a manager and regional vice president of ASME and has served on many of its important committees. He became a Fellow of the society in 1936.



James D. Cunningham

How We Use Industrial Process Instruments in Power Plant Control

In two power plants and water treatment plants of Humble Oil & Refining Co., at Baytown, Texas, instrument department has applied standard industrial process instruments to control of power plants. . . . Unusual combination of rate-of-flow control on three boilers for controlling fuel supply, fourth boiler maintaining main steam header pressure. . . . Boilers fired by fuel gas and acid sludge from refinery. . . . Control of acid in water treatment plants and control of chemicals in entire treatment process by flow ratio and level controllers. . . . Several shopmade valve positioners and other devices, as well as standard diaphragm valves, used to permit control by conventional recorder controllers, level controllers and ratio controllers. . . . Flexibility in boiler operation and control of pressure reducing and desuperheating systems. . . . Results are: improved maintenance; costs on heavy equipment reduced; and problems of instrument and control maintenance simplified . . . Details of control systems and equipment employed

By W. H. FORTNEY

Foreman, Instrument Department, Humble Oil & Refining Co., Baytown, Texas

THE MODERN catalytic cracking unit in a refinery may represent an investment of several million dollars. Operating temperatures above 1000 F are common in these units. Problems of erosion and corrosion have been overcome; extremes of high and low temperature and pressure, complicated chemical reactions, and precise separation are encountered in many of the processes. Our instrument men feel that when conventional industrial instruments will successfully measure and control such a variety of materials and conditions, there is no reason why they can not be used in our power plants.

Simplification and standardization are necessary in an industry like ours that does a large amount of research, because the flow plans and operating conditions are changed often to increase production or improve product quality. As a result, the trend in our industry is toward the use of standardized instruments, as far as possible, where revisions are simple changes of range and where every instrument may be used on another application if not needed where originally installed.

With the cooperation of our Utilities Department, my instrument organization, in the manner described below, has been able to apply a number of conventional instruments to our boiler houses and the water treating plants that supply them. The results have been gratifying and the problem of instrument maintenance has been simplified. We believe that operations have been improved and that maintenance costs on the heavy equipment have been reduced.

General Boiler Plant Arrangement

We have two high-pressure boiler installations about one-half mile apart. The first two boilers in the first high-pressure installation (known as our No. 5 Boiler House) were built in 1931. Industrial instruments, as we know them today, were not available at that time. The first water treating plant was erected along with these two boilers. Two more boilers were added in 1937 and 1938, and an addition was built on the water treating plant.

The second installation consists of three boilers erected during the war to carry on our aviation gasoline

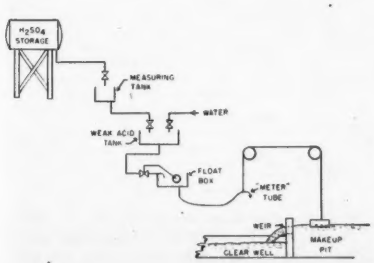
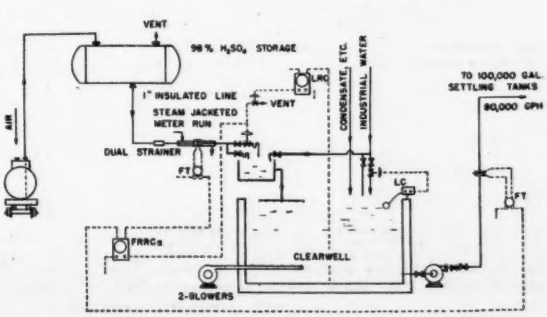


Fig. 1. — Above. Original acid handling system for No. 1 Water Treating Plant

Fig. 2. — Right. Revised acid handling system for No. 1 Water Treating Plant as now in use, showing all equipment on continuous ratio flow control. Key: FT = Flow transmitter; FRRCa = Flow ratio recorder controller with pneumatic transmission; LRC = Level recorder controller; LC = Level controller



THE AUTHOR

W. H. Fortney, author of this article, has been Foreman of the Instrument Dept. of Humble Oil and Refining Co., Baytown Refinery, Baytown, Texas, since 1937 and has been with the Company since 1925, except for a short period in 1926 and 1927 spent as electrical foreman on Construction at Crown Central Refinery, Pasadena, Texas. His present Instrument Department of 153 men is probably the largest such department in the petroleum industry.

Mr. Fortney says he was "exposed" to chemical and electrical engineering at the University of Texas 1920-23, but did not obtain a degree. He then did pyrometer work with The Texas Co. at Port Arthur until 1925, when he joined Humble.

He holds a patent on a gravity recorder for liquids, has written many technical articles, was the first president of the Houston Instrument Society, now Houston Section of Instrument Society of America; is chairman of ISA Technical Committee on Recommended Practices. He has been a member, since its organization, of the steering committee for the Short Course in Instrumentation for the Process Industries at Texas A & M College. He has delivered several papers before the ISA.

Besides all these activities, Mr. Fortney has found time for one successful and one unsuccessful venture in politics; has been active in civic oganizations.

Finally, Mr. Fortney says, "I fish when I have time, but *never* catch any."

production. The first section of the water treating unit at this plant was installed to service the first two boilers and the second section was completed with the third boiler in 1945. These plants are known as No. 6 Boiler House and No. 2 Water Treating Plant.

The No. 5 Boiler House supplies steam to three 7500-kw turbines from a header at a nominal pressure of 600 psi with 100 F superheat. Part of the 600 psi steam from this plant is used at four separate process units.

The boiler leads are headered together, although each turbine could be supplied from an individual boiler.

The No. 6 Boiler House supplies steam to two turbines identical with those at the original plant. A third turbine is on order. These boilers are likewise headered but may be segregated to individual turbines if desired. No 600-psi steam from this plant is used for process purposes.

Each boiler house has three reducing valves to deliver steam into the yard system, which operates at a nominal pressure of 150 psi.

The 150 psi system supplies the refinery with steam for pumps, heaters, and for process requirements. The 150-psi equipment exhausts to a system maintained at approximately 15-psi. Exhaust steam is used for heating in some process units and for stripping and the like.

Condensate is recovered from process operations wherever possible and is returned to both boiler houses.

We believe we can take care of all measuring and controlling problems in water treatment and steam generation using conventional instruments. Here is the way we have already applied them.

No. 1 Water Treating Plant

Our No. 1 Water Treating Plant was built to supply the first two boilers and was built before the era of modern instrumentation. Recovery condensate made up about 50 per cent of the total feedwater to the boilers. The makeup water supplied to the treating plant came from deep wells. This water fortunately was of uniform quality and the demand was also fairly constant.

This well water contains 600 ppm total solids of which 360 ppm is bicarbonates; the hardness is 28 ppm; silica content averages 21 ppm and calcium 10 ppm. The water has a pH value of 8.3.

The raw water supply to both plants was augmented during the war with "surface" water from the San Jacinto River. This water contains 225 ppm total solids of which 75 ppm are bicarbonates, 21 ppm calcium; the hardness is 50-55 ppm. The pH value is 8.3, the same as the well water. When the entire raw water makeup comes from the surface water system, acid treatment is discontinued because of the low bicarbonate content.

The first step in the treatment is introduction of sulphuric acid, to convert the bicarbonates, and release the CO_2 formed in the reaction by blowing with air.

Figure 1 shows all the original acid treating system in this plant. It was necessary to draw the acid into a measuring tank and dilute batchwise into a weak acid tank. The diluted acid was introduced into the clearwell by means of a "meter" tube. The differential head pressure across the tube was regulated by a constant level in a float box while the tube was raised or lowered through a pulley arrangement by a float behind a weir in the makeup pit. This system was relatively simple but required undue attention from the operator. Mixing batches of weak acid was a regular chore.

Changes in Acid Control, No. 1 Water Treating Plant

We have replaced all of this equipment with continuous ratio flow control as shown in Fig. 2. The measuring tank, mixing tank, float box, and meter tube assembly of Fig. 1 have been dismantled. The acid is now measured in a small stainless-steel meter tube with an orifice and conventional manometer type transmitter.

The acid meter and equipment consists of a 0.546 in. I.D. stainless steel tube with a 0.101 in. I.D. orifice using a 50-in manometer without any

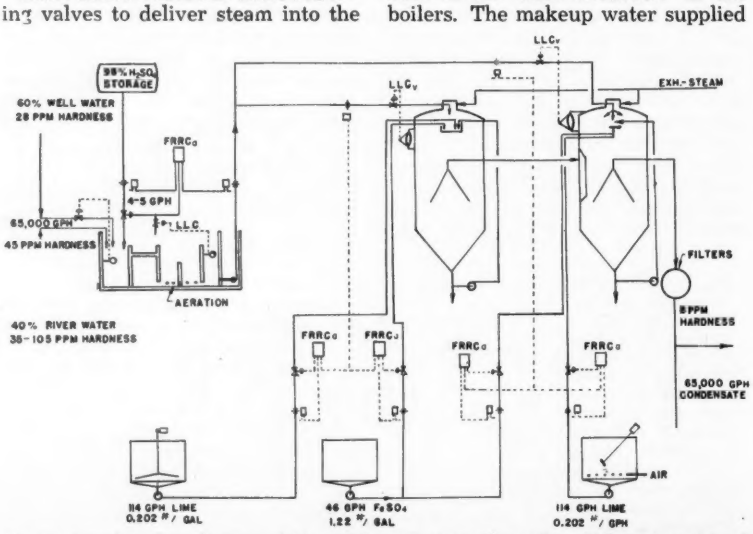


Fig. 3. Complete flow diagram of No. 1 Water Treating Plant. Key: LLC = Liquid level controllers; LLCv = Liquid level control valve; FRRCa = Flow ratio recorder controller with pneumatic transmission

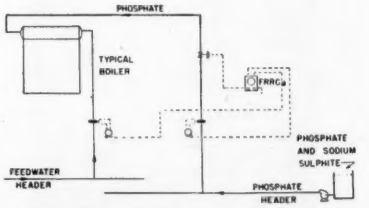


Fig. 4. On each boiler in No. 5 Boiler House, flow transmitter on feedwater header resets controller operating valve on phosphate and sodium sulphite line. FRRCa = Flow ratio recorder controller with pneumatic transmission

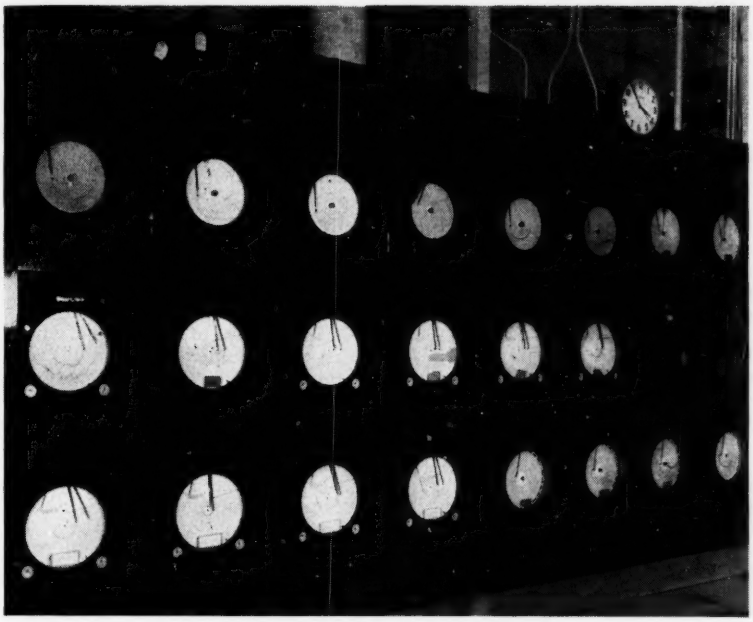


Fig. 5. Control panel for No. 1 Water Treating Plant

sealing medium. As a precaution we installed dual strainers of 100 mesh stainless steel screen ahead of the orifice. The entire metering system is steam traced and insulated.[1] The rate is reset by a conventional orifice and transmitter on the total discharge from the clearwell.

The meter factor is 1 gph against a 0-to-10 square root scale. Injection rates as low as 1 gph have been measured and controlled without difficulty.

The level in the clearwell is controlled by a conventional pilot-operated, float-type level controller. The bubble-type level recorder on the clearwell has a pilot attachment to operate a small valve, which vents the air to the diaphragm on the acid valve, closing it if the water supply should fail. This same instrument could be used to control the main water supply; or the output of the float type level controller could operate the safety vent valve on the acid, thus eliminating one instrument.

Flow Diagram for No. 1 Water Treating Plant

Figure 3 shows the complete flow diagram of the No. 1 Water Treating Plant. The clearwell pump discharge splits to supply the two settling tanks on liquid level control (conventional LLC's and valves).

A difference between the internal design of the two tanks will be noted. The original tank shown on the left does not have a phosphate section. The newer tank was furnished with a phosphate section, but it cannot be used as such.

The chemical feed control arrangement furnished on the original tank consisted of an impeller-type totalizing meter with electrical contacts, which would start and stop motors lowering swing lines into the solution tanks. The solutions were drained into small suction boxes ahead of the injection pumps. Pump suction was maintained in the boxes by admitting condensate through small float valves.

The system originally installed on the second settling tank was identical with the first except that an orifice and integrating manometer type meter was used to measure, totalize, and operate the control relays.

Thus we had rather complicated electrical systems that required considerable maintenance after the first year's operation. The feeding rate was batchwise, although the effects of intermittent feeding might have been reduced by the capacity of the settling tanks.

Now each of the split streams of water to the settling tanks has a conventional orifice and flow transmitter. The rates of injection of lime slurry and ferrous sulphate solution (coagulant) are reset by the transmitters measuring the flow to the tanks.

The lime slurry is measured in a standard 1 in. pipe meter run. The orifice is 0.446 in., the meter factor is 4 gph on the 0-10 square root scale. The meter lines are purged

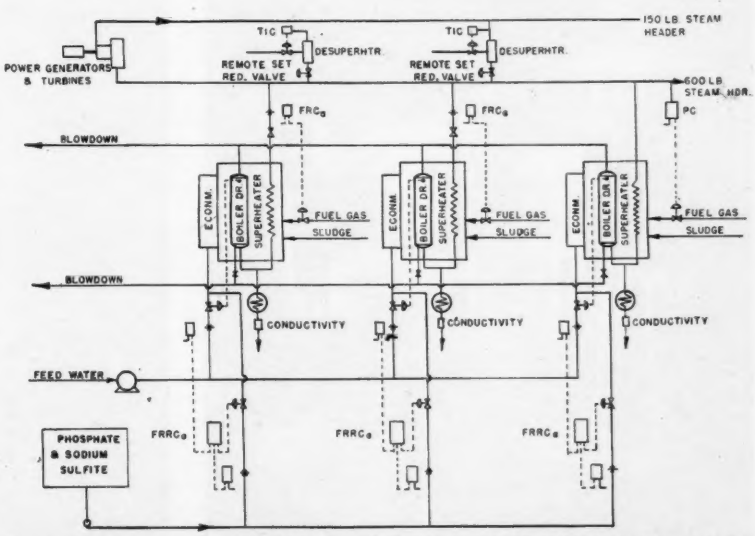


Fig. 6. Flow diagram of controls for No. 5 Boiler House, showing three of the four boiler units (fourth unit, on rate-of-flow control, omitted to simplify diagram). Key: TIC = Temperature indicator and controller; FRCa = Flow recorder with pneumatic transmission; PC = Pressure controller; FRRCa = Flow ratio recorder controller with pneumatic transmission

[1] Steam tracing resulted in an improvement in measurement which we had not anticipated. Theoretical calculations indicated that the greatest error in measurement of the acid flow would be caused by changes in Reynolds number. These errors (on paper) range from 0 to 2.4 per cent, with the meter constant figured for a pen reading of 5 on 0.0-to-10 square-root chart.

Computing our coefficients at a flowing temperature of 125 F, the diameter ratio was kept low to operate at as high a Reynolds number as possible. At Reynolds numbers of 60 to 10,000, the variations in flow range to 12 per cent. This we consider to be out of the normal range of accurate measurement with an orifice meter, and the lower Reynolds numbers are encountered at lower temperature.

Suprisingly or not, our meter readings have consistently checked tank gages at both plants.

In the orifice design it was impossible to follow ASME standards. For example, the cylindrical section of the bore, or thickness of the plate at the orifice, is limited by ASME to 1/30 of the pipe diameter, 1/8 of the orifice diameter, or 1/4 of the dam height. Thus, with an orifice of 0.101 in. I.D., the plate thickness at the orifice would be slightly more than 0.01 in.; this would not be substantial enough for continuous service and this thickness was increased to approximately 1/32 in. Pipe tap locations conform as nearly as possible to ASME specifications in proportion to connections for 2 in. pipe.

with steam condensate through a fixed restriction orifice.[2]

The ferrous sulphate solution used as a coagulant is measured in a stainless steel tube 0.742 in. I.D., orifice diameter 0.255 in., meter factor 7 gph.

At this plant all the water from the first settling tank flows into the annular (phosphate) section of the second tank. Phosphate injection into the second tank was tried but was not successful.

Pressure is maintained on the settling tanks from the exhaust steam system. Part of the sludge from the bottom of the tank is recirculated. The water from the settling tanks flows into anthracite filters and to the feed water pumps.

Desired reactions are completed when phosphate and sodium sulphite solution is injected directly into boiler drums. This is controlled from the water treating plant. Originally the phosphate was measured by small high-pressure displacement meters. These meters gave considerable trouble and did not give an indication of rate-of-flow.

We now use ratio flow controls of the same type used on the other chemical streams. These four controllers are reset by the flow transmitters on the feedwater lines to the individual boilers; a typical installation is shown in Fig. 4.

These meter runs are of stainless steel 0.957 in. with orifice 0.225 in. and meter factor of 7 gph.

Miscellaneous instrumentation in the water treating plant includes static and bubbler type levels on the chemical tanks, a conductivity recorder that may be switched to a sample from any of the four boilers; and various flows, pressures, and levels indicated or recorded. The complete water treating panel is shown in Fig. 5.

Controls for No. 5 Boiler House

Figure 6 illustrates the flow plan of this steam generating unit. Only three boilers are shown, merely to simplify the drawing.

Each of the four boilers has a capacity of 350,000 lb per hr, discharging into a 600-psi header to supply the three turbine generators.

As stated before, the treated water is augmented by recovered condensate from process units. Two 10,000-barrel steel storage tanks give surge capacity for the condensate, which may vary from 10 to 60 per cent of the total water. (The level in these tanks is indicated on the instrument panel at both the boiler house and water treating plant.)

Boiler water level is maintained by thermostatic regulators with hydraulically-operated valves. Feedwater flow is measured by ordinary manometers and flow nozzles. These measurements are transmitted to the boiler panel for recording and to the water treating plant for proportioning the phosphate solution.

Our four boilers are fired by conventional industrial instruments operating pressure-balanced valves on fuel gas from the yard distribution system. However, at this plant, the fuel gas merely augments liquid fuel in the form of acid sludge, which must be consumed for disposal, from plant operations. Control of the sludge burning is manual; automatic control would be difficult, we feel, because this material contains slugs of coke and asphaltic materials not easily measured on pressure or flow; although a constant header pressure is maintained by controlling the steam to the pump. Fortunately, the excess fuel required in the form of gas is sufficient for control of the fires.

The fires were originally on remote manual control. They are now instrumentized for maximum operating flexibility. Each boiler may be fired by pressure control on the superheater outlet or by rate-of-flow control of its steam production.

Other variations include the possibility of firing one boiler to control the 150-psi supply, with one de-

[2] This stream was originally measured in a flow nozzle, because it was thought that the lime would build up behind the orifice plate. Later experience proved that the nozzle would become plated with lime, but that the orifice plate was satisfactory. In either case, the flow is downward in a vertical line to prevent settling out of the suspended solids.

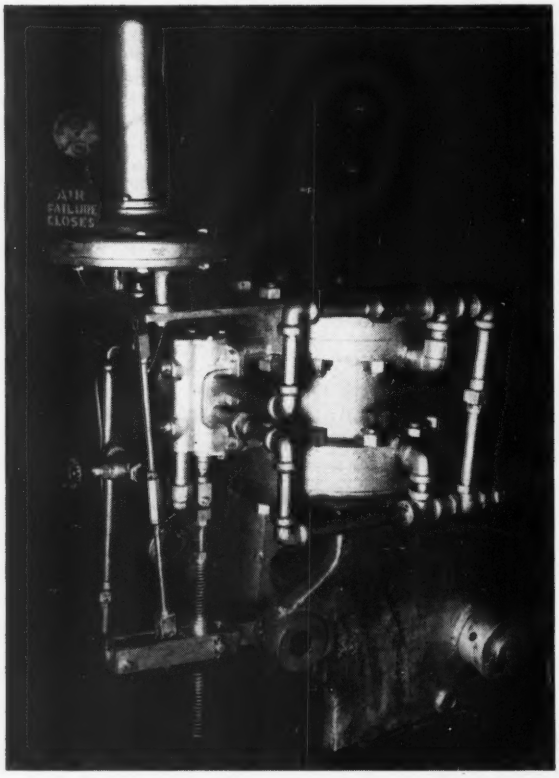


Fig. 7. Shopmade positioner for operation of hydraulic-powered pressure-reducing valves; manual control from boiler panel

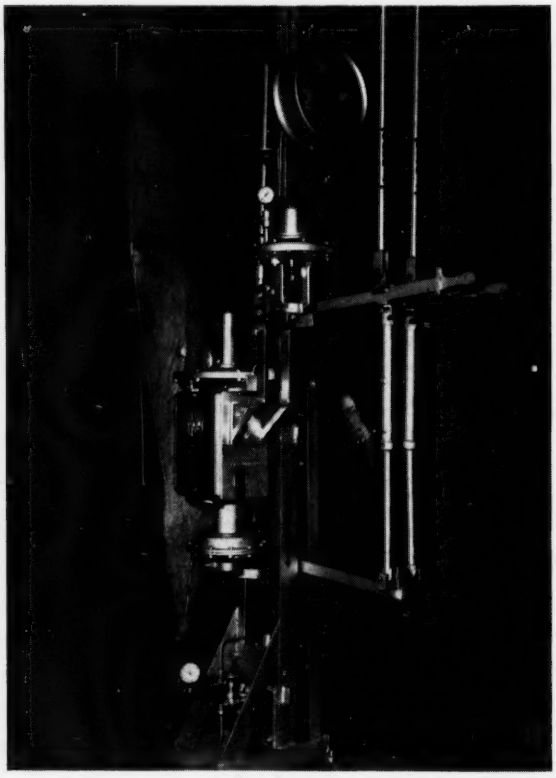


Fig. 8. One of the induced draft damper regulators equipped with a diaphragm to position it manually from the boiler control panel

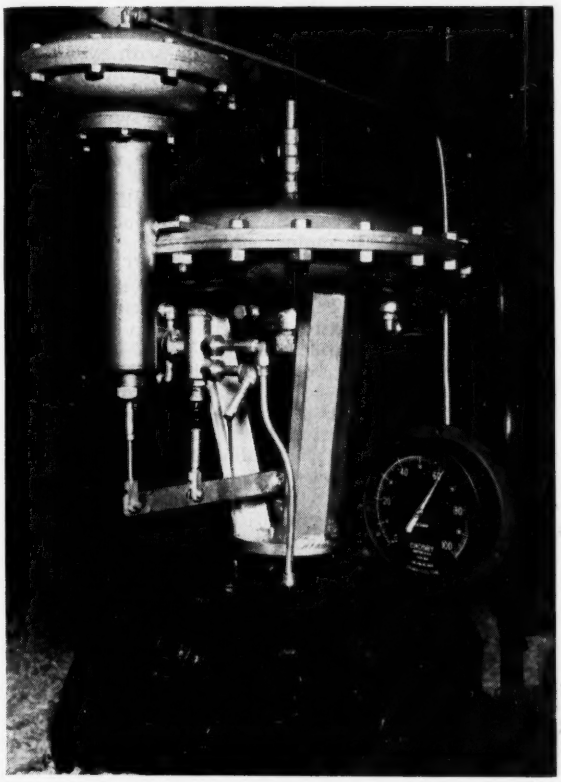


Fig. 9. In No. 2 Water Treating Plant, this three-way valve is installed on make-up water line as explained in text. It is hydraulically operated and controlled by a pneumatic positioner, which was shopmade

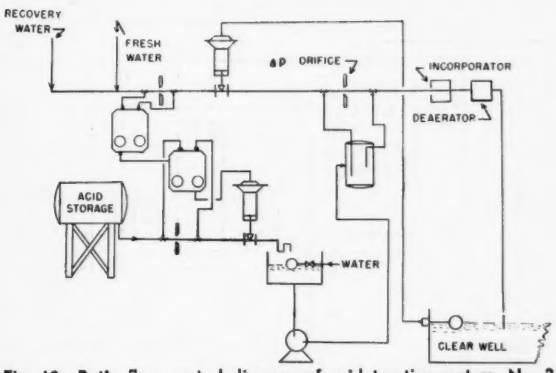


Fig. 10. Ratio flow control diagram of acid treating system, No. 2 Water Treating Plant

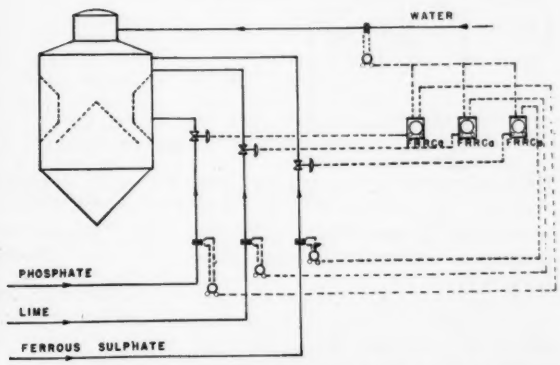


Fig. 11. Diagram of control system for three chemical streams flowing to a settling tank, No. 2 Water Treatment Plant. FRRCa = Flow ratio recorder controller with pneumatic transmission

superheater on back pressure control.

Rate-of-Flow Control on Boilers

A typical operation would be three boilers on fixed output by rate-of-flow control, with the fourth boiler maintaining header pressure. We believe this system to be unique, at the very least, unusual. The plant obviously could not be maintained on rate-of-flow unless the excess could be absorbed by the 150-psi system; however, the three boilers on constant output will operate at maximum efficiency and with remarkably smooth control, while the load changes can be "juggled" by a single boiler. This system, in addition to its evident economy of operation, provided the maximum in ease of control to the operator, who has only one boiler that may require a nominal amount of attention.

The generator turbines discharge at 150-psi into the yard system. Three desuperheaters deliver excess 600-psi steam into the same system.

These desuperheaters were originally installed to hold reduced pressure on the 150-psi system. The first two reducing valves were hydraulically operated and the third valve was furnished with a pneumatic actuator. Temperature was controlled with bimetallic thermostats.

The two hydraulically-operated reducing valves have been revised by the installation of shopmade positioners, as in Fig. 7, which permit control from conventional instruments with 0-15 lb output. The pneumatic valve, which operates at 0-60 lb, is equipped with a 2-1 relay or booster valve, which also permits operation by conventional instruments.

The bimetallic thermostats have been replaced with mercury-filled bulb-type temperature controllers, operating conventional diaphragm valves on the water injection to the desuperheaters.

Here again we have selective and flexible control: rate-of-flow of desuperheated steam; back pressure on the 600-psi header, rate-of-flow from boiler output with one or more boilers on pressure control; reduced pressure control on the 150-psi system; or remote manual positioning.

Methods of control may be chosen to suit the demands from the turbines or from the 150-psi system. It might be mentioned that two other boiler houses deliver steam into the 150-psi system, and that the refinery load may be "swung" by either the 150-psi boilers or the 600-psi boilers.

Evidently such flexibility of operation is due to the ease by which the flow of fuel may be controlled. We see no reason why liquid fuel could not be controlled by the same instruments by substituting reset rate-of-flow control or simple conventional diaphragm valves.

We do not have an ideal setup for control of furnace draft. Induced and forced draft on the first two boilers was originally controlled by motor-driven valves with push button controls on the panel. These have been replaced with conventional diaphragm valves and remote pneumatic manual control units on the panel.

There is no reason why the induced draft could not be controlled by conventional instruments operating the valves on the steam lines to the fan turbines, since the induced draft is maintained at a constant value.

Automatic control of the forced-draft fans would require an instrument reset by another instrument giving an indication of the demand for air for combustion. This impulse might be taken from the boiler output, or preferably, from actual flow of fuel.

Induced draft on the two newer boilers is controlled by damper regulators as in Fig. 8. The control point is set from a manual loading station on the boiler control panel.

Forced draft on both boilers is

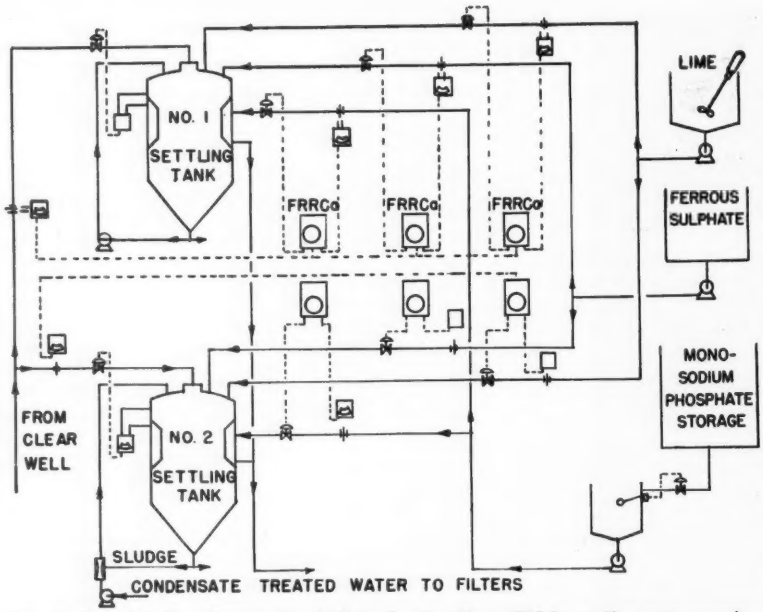


Fig. 12. Complete flow diagram, No. 2 Water Treating Plant. FRRCa = Flow ratio recorder controller with pneumatic transmission

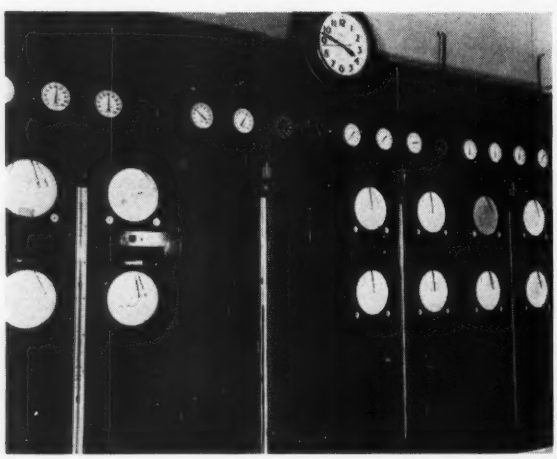
maintained by remote manual positioning of hydraulic damper controls.

We are now completing a new air-conditioned control room for this plant. All flow and level measurements will be pneumatically transmitted to the panel. Instruments formerly scattered around the unit will be concentrated for operating convenience.

The usual miscellaneous instruments also appear on the panel. These include differential type level recorders, draft indicators, a four-point strip chart CO_2 recorder and temperature potentiometers.

The power house containing the turbine generators operates as a separate unit with only the turbine steam flow recorder on the boiler panel.

Fig. 13. — Below. Control panel for No. 2 Water Treating Plant



Control of No. 2 Water Treating Plant

This water treating plant which supplies our No. 6 Boiler House is of later design and all chemicals are retained within the plant. The raw water makeup is the same as the No. 1 plant although there are times when the total feed comes from surface water. This water comes from the after coolers of a nearby air station and from the compressors and turbine generator cooling systems.

This makeup water is on liquid level control in the clearwell. A three-way valve diverts the excess to a nearby cooling tower. This three-way valve is equipped with a hydraulic actuator with pneumatic positioner. This assembly was designed and built in our shop (Fig. 9).[3] A second pilot on the same float shaft provides emergency makeup to the clearwell from the refinery industrial water system.

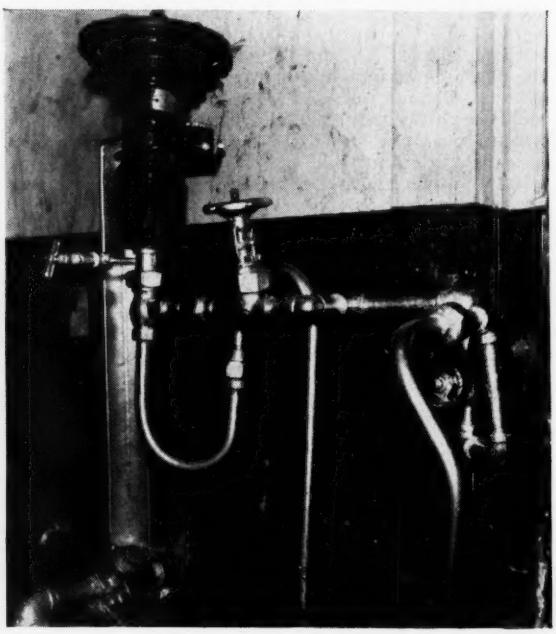
This plant uses an orifice type incorporator to mix the acid into the incoming water and the CO_2 is removed in a deaerator. The clearwell merely serves as surge capacity.

The original acid-treating equipment consisted of an integrating manometer-type flow meter with adjustable electrical contacts, which controlled a series of small helicoid gear pumps to inject the acid into a dilution box. This arrangement might possibly be an improvement over the older installation of the No. 1 plant but nevertheless it was quite unsatisfactory. The gear pumps required considerable maintenance which involved more than one mechanical craft.

This system is now on ratio flow control as illustrated in Fig. 10. Incidentally, the acid storage tanks at both water treating plants have base elevation sufficient for gravity flow of acid at all times, and pumps or blowcases are unnecessary.

The present installation is identical

Fig. 14.—Right. Acid injection valve, No. 2 Water Treating Plant; this is the valve shown diagrammatically in Fig. 10, controlled from water flow



[3] The writer does not know of a fully hydraulic diaphragm-type actuator. "Spring-less" pneumatic valve movers are available. We prefer the diaphragm-type hydraulic actuator illustrated in Fig. 9 to the piston and lever for all short stroke valves with unbalanced plug thrust. Mechanical advantage is obtained by simply increasing diaphragm area. Lost motion and angularity of linkage is eliminated. The spring and diaphragm arrangement receiving the impulse from the control instruments gives more positive repositioning of the pilot, we believe, than the bellows and pneumatic relays used on instrument-type pneumatic valve positioners.

with the one described for No. 1 plant and was actually installed before the one at the older plant. When we dismantled the acid pumps and their suction tanks, the space in the treating plant thus cleared was large enough for the entire plant instrument panel.

The acid injection valve is shown in Fig. 14. The stream through the valve at the time the picture was made was 1.75 gph.

Figure 11 illustrates a schematic arrangement of the control system on the three chemical streams to a settling tank at this plant. It will be noted that the phosphate solution is injected into the tank instead of into the individual boiler. This simplified the operations and reduces the number of instruments proportionately. A complete flow diagram is shown in Fig. 12.

The second settling tank at this plant was completed in 1946. During preliminary engineering discussions of design of the plant, sometime during 1944, we had proposed ratio flow control on the chemical streams at all plants; justification for this type of control could easily be developed when comparing engineering estimates for the necessary treating equipment on the second settling tank.

Considering the control of the acid treatment the most difficult of all, we made a trial installation. This installation was so successful that no alterations whatever have been made and only minor parts replacement have been necessary. It is the writer's opinion that the total installed cost of our ratio flow equipment is in the neighborhood of 25 per cent of that of the original equipment, based on material and labor cost at the time of the change over. Here we take credit for elimination of duplicate chemical feed tanks, pumps, and so on.

Figure 13 shows the panel of No. 2 Treating Plant.

Control of No. 6 Boiler House

Unusually favorable operating conditions exist at this boiler plant. The plant is operated on a constant load basis as far as possible. No process units must be supplied with 600-psi steam. Regardless of turbine demand, all of the production is finally delivered to the refinery 150-psi steam system as turbine discharge or through the reducing stations. No attempt is made to swing the main refinery 150-psi load from this plant, except in emergencies.

There are three boilers, each with a capacity of 275,000 lb per hr.; another similar boiler is under design. Two turbines identical with those at the older plant are installed; a third turbine is on order.

A limited number of replacements were necessary to equip these boilers with conventional instruments, and these replacements were confined to the first and second boilers. All measurements were originally made with conventional industrial instruments, the sole exception being the first two desuperheaters. If we decided to control from one of our measurements on the panel, we could easily remove the recorder and replace it with a controller made by the same manufacturer, which would have identical panel dimensions.

Here we have maximum flexibility in control; Each boiler has a pressure controller and a rate-of-flow controller on the boiler output; either may be switched to the fuel gas valve.

Likewise the desuperheater stations have been arranged for selective control; the choice here may be: (1) rate-of-flow on desuperheater steam; (2) back pressure on 600 lb header (all three boilers could be on rate-of-flow control) or (3) holding reduced pressure on the 150-lb line.

No change has been considered in the boiler level controls.

Considerable trouble has been experienced with all of our reducing valves. Two of those at No. 6 Boiler House are pneumatic and identical to the third one at No. 5 Boiler House, using shop-made 4-to-1 booster pilots between valve and instrument. The third valve at No. 6 plant is an angle type which was originally furnished with pneumatic actuator. The pneumatic actuator was entirely unsatisfactory because at times there was no relation between diaphragm pressure and valve position, due to unbalanced forces. This valve is now operated by a hydraulic piston and lever arrangement, which required several changes before satisfactory operation was obtained.

The plant has an emergency fuel oil system which has never been used.

At this plant we cannot boast of automatic control on furnace draft. Actually, too much investment in draft control equipment cannot be justified where such ideal operating conditions exist; no solid fuels, no sludge to contend with; not even the problem of major load changes. Up to this time, draft fans or dampers have been controlled by manual setting or remote manual resetting of speed control.

This plant also has conventional temperature, liquid level, pressure, and CO_2 indicators and recorders.

A further application of ratio flow control is now being given serious consideration. We have installed orifice meters on the continuous blowdown lines from these boilers. It is expected that the Utilities Department will propose ratio flow control on the blowdown, the rate to be reset by feedwater flow. Such a system should result in a blowdown stream of consistent solid content. Economies should be effected in chemicals and fuel, to say nothing of maintaining cleaner boilers.

Possibilities for Further Development

There is no reason to be content with a few applications such as those listed here; further improvements will always be made. But each must have an economic justification.

Some of the possibilities include: improvement in control of furnace draft and development of an optimum method of resetting the control point; ratio control of blowdown. Automatic cycle control of the filters in the water treating plants should be evaluated. This is entirely feasible: differential meters across the filter beds could start cycle controls to perform the backwash operation and put the filters back on the line.

Some means of measuring the consistency of the sludge drawn from the bottom of the settling tanks might be developed. This could be used to set the rate of sludge recirculation, which, in turn, might effect a saving in chemicals.

Bulk chemicals might be used in the treating process, supplied by continuous dry feeders, with savings effected by purchasing in bulk quantities.

Conclusions from Our Experience

No member of my immediate organization is an expert in the operation of power plants or their accessories. My company is interested in the production of steam and electrical power merely to meet the operating requirements of our refinery. Our refinery organization is interested primarily and exclusively in the manufacture of petroleum products. Our Departmental organization fortunately has been able to apply to the power plants some of the "know-how" accumulated from refinery operations. We are able to give the power plant operators much better service on their controls because our maintenance men are familiar with these instruments.

We believe the results we have obtained, beyond the simplification of maintenance problems, have given us still greater justifications. Maintenance on equipment other than on instruments has been appreciably reduced, chemical consumption has been reduced, and operations have been improved.

We quote a report from the Utilities Division: "Improvements in water treating methods have improved boiler operation to the point where turnarounds are usually made because of the necessity for furnace repairs, valve maintenance and work on the draft fans. In the past, turnaround periods were based on the amount of scale laid down in the boiler tubes and it was necessary to bring the boilers down at regular intervals to turbine the tubes. These tubes are now run about once a year. They were formerly drilled during every 60-day turnaround."

Fig. 1 Some of the most majestic mountains in the world are located in Southeast Alaska. Shown here is Thomas Bay Cove, Tongass National Forest, Alaska. Contrary to ideas widely prevalent in the "States" comparatively warm winters and cool summers are the rule in Southeast Alaska. The average summer temperature along the coast line lies between 50 and 55 F. As for winter, the average temperature for January in Sitka is half a degree higher than in St. Louis, Mo.

Is ALASKA'S POWER Potential Being Overlooked?

By RICHARD LaCOSTE

ALERT AND AGGRESSIVE industrialists on both sides of the border could do worse these days than to cock an appraising eye toward North America's last and first frontier: Alaska.

Today, in southeast Alaska alone, there are about 50 going water power developments producing somewhat more than 30,000 hp. In addition, 150 potential power sites and projects already have been surveyed and appraised from an engineering standpoint. This small section of power potential in Alaska is well worth attention from men of vision and energy and faith in the future.

In this area, Ketchikan, with a municipally-owned plant developing around 3500 hp, has the largest public utility installation. The Alaska Juneau Gold Mining Co. with 12,000 hp is the largest of the industrial companies which generate power. Projects already developed in this region number approximately 25.

Practically all of the 200 projects —the 50 going water power developments and the 150 potential power sites and projects—are shoreline establishments. They involve little more than ten per cent of the 60,000 square miles in the area. Estimates indicate that in the mountainous hinterland, three to four times as much power awaits future harnessing.

Thus, water in hundreds of streams, capable of developing millions of uninterrupted horsepower flows down to the sea from the mountain lakes, glaciers and drainage basins of a land rich in untapped mineral resources.

Recently, the American Newspaper Guild, in pointing up the newsprint problem, requested the development of newsprint manufacture in Alaska. The Guild asked for government financing. Even without government help—and it would be available—private industry could develop these areas and reap rich rewards. Help, however, would be an incentive.

In southeast Alaska lies a virgin timber stand of 80 billion board feet —75 per cent within 2½ miles of tidewater. Under proper management this stand could produce in perpetuity a million tons of newsprint paper a year—or about 25 per cent of the annual consumption in the United States.

The timberlands of the Tongass National Forest have been divided into four sustained yield units. These units will permanently support large pulp mills and correlated saw mills, plywood plants, shingle mills and other timber-using industries. The four units are: Sitka—400 tons daily; Juneau—700 tons daily; Petersburg-Wrangill—700 tons daily; Ketchikan —1200 tons daily.

These units are so laid out that sufficient and reasonable-cost power is available for development. The power sites are small enough to allow a pulp company to develop the amount of power it needs. In all cases, power from a number of sites can be readily combined by short transmission lines in order to get 40,000 to 60,000 hp. This horsepower is sufficient to operate large newsprint mills—the heaviest power users of all types of pulp mills.

Eventually, far-sighted industrialists will develop the area's vast virgin forests as the probable leader in a future development of extensive power-dependent operations. These forests, of almost tropical density, are predominantly Western Hemlock and Sitka Spruce mixed with Western Red and Alaska Cedar. Small pure stands of each species are occasionally found.

The average stand per acre for the commercial forest as a whole is about 25,000 board ft, though 50,000 ft per acre frequently occurs on small units. Most merchantable trees are from 2 to 4 ft in diameter and from 90 to 140 ft high, but spruce trees 7 ft through and 200 ft high are common.

The first water power development of substantial size in southeast Alaska was installed at Treadwell Mines, near Juneau, in 1882. The hydroelectric public utility at Ketchikan followed in 1901. The first long-term inventory of water power, timber

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BETZ

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and other resources was begun by the U. S. Forest Service following inclusion of most of the area in the Tongass National Forest between 1904 and 1909. From 1911 to 1945, 51 gaging stations to measure and record the flow of water discharged by the various streams in 47 watersheds were set up by the U. S. Geological Survey and the U. S. Forest Service.

Generous and fairly well spread over the year as the precipitation is, the volume of water flowing in the streams varies with weather conditions. Fortunately, the lakes or series of lakes in a number of the basins are natural stream regulators. Some of the most desirable power sites are those with a "hanging lake" reservoir a short way inland from a power plant location at tidewater.

These "hanging lakes" on the steep mountains of southeast Alaska and the heavy rainfall there afford excellent sources of hydroelectric power. All of the six larger towns of that region except Wrangell use public utility hydroelectric power. Mines, salmon canneries, cold storage plants for fish, and other industries where public power is not available are generally powered from hydro plants developed by these concerns for their own individual use.

Outside of southeast Alaska, existing hydroelectric power development is confined largely to the south coast. This power consists of public utility plants at Cordova, Valdez, Seward and Anchorage. Numerous other developments of a few hundred horsepower each are those of industrial companies—principally salmon canneries and mines.

The Eklutna Lake plant of 2,500 hp, owned by the city of Anchorage, is the largest developed hydroelectric plant in the Territory outside of southeast Alaska. This lake is capable of supporting an increased development, and surveys have recently been completed for a plant of at least 17,000 hp there.

Some of the great rivers of interior Alaska have potential hydroelectric sites of huge capacities. Some of these equal the power potential of the Columbia River and its larger tributaries. The greatest of these is on the Yukon River at Rampart, 90 miles northwest of Fairbanks. Engineers claim this is one of the largest power sites in North America, with a capacity which may be in the neighborhood of 2,000,000 year-long horsepower.

Fig. 2 Above — A primitive power development in Alaska. Many of the power sites are small enough to allow a pulp company to develop the power it needs

Fig. 3 Left—This roaring waterfall is one of 150 power sites already surveyed from an engineering standpoint

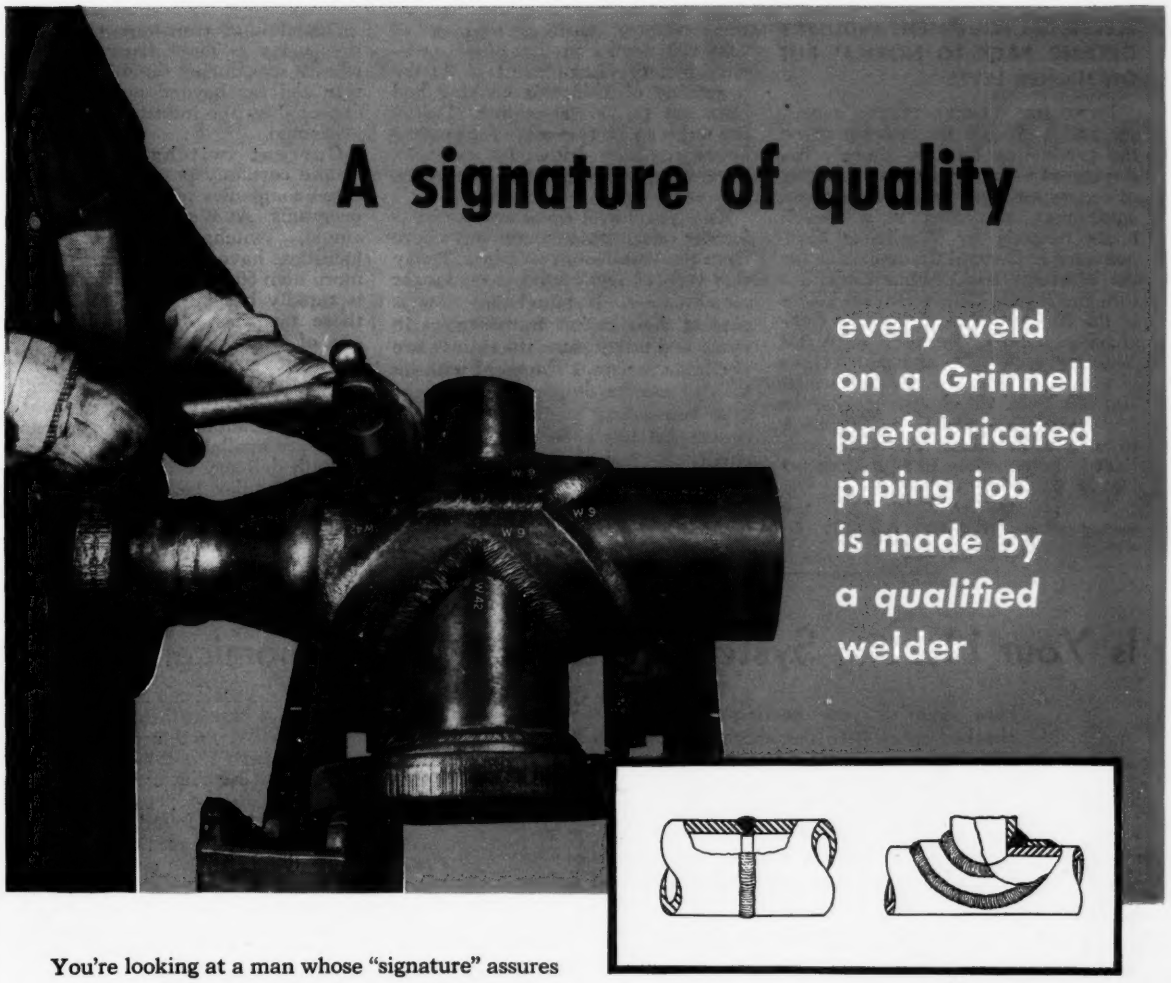
Another of big potential power sites of the Far North is located largely in a nearby section of Canada. But the power houses and much of the water conduit would be located on the Alaska side of the international line. This project involves the huge lake region which forms the headwaters of the Yukon River in British Columbia and Yukon Territory, Canada.

A dam of moderate size across the Yukon a short distance above the town of White Horse would create an enormous reservoir on the headwater lakes at an elevation of approximately 2100 ft. Tunnels with a total length of about 15 miles through the crest of the coast range of mountains which separates the Yukon River and the Alaska coastal drainages would permit the diversion of the entire flow of the Yukon headwaters to a point near tidewater elevation close to the town of Skagway in Southeast Alaska. Apparently, the power capacity would be well above the 500,000 hp of the Bonneville Dam on the Columbia River.

From the standpoint of waterpower, its mountainous topography and unusually steady rainfall make southeast Alaska a natural hydro power plant. The crest of the mainland is largely within 25 miles of tidewater; and the ridges are covered year-'round with snow and ice. The intervening area is divided into hundreds of watersheds dropping to the sea. These range in size from 200 miles, as is the case of Speel River Basin, to a fractional square mile. Thousands of small glaciers occur in the mountains, some clinging to steep slopes and others continually falling in broken masses into the sea. They store tremendous amounts of water. Waterfalls, sometimes starting thousands of feet high, plunge down through series of cascades and lakes into the valleys or the sea. Going the same way are nine principal rivers and numerous lesser streams.

According to the 1940 census, there were in southeast Alaska, 25,241 inhabitants, or 1 person to 1.5 square miles. This number has been increased slightly since war's end. Daylight hours per day in July are 18 and during December and January rarely exceed seven.

This is the picture of the power potential and possibilities for the future. Today, men of vision and with faith in the future are pondering this power potential of our "First Frontier."



You're looking at a man whose "signature" assures quality welding of piping. He's a Grinnell welder and, as every Grinnell welder, he is qualified by Grinnell according to a procedure which conforms to A.S.M.E. Boiler Construction Code, Section 9. After qualifying, he is given a number which he "signs" adjacent to each weld he makes.

Quality welding is only one of a long chain of responsibilities assumed by Grinnell on every prefabricated piping job . . . from the interpretive engineering to the on-time delivery of the fabricated piping. Such responsibility requires facilities for metallurgical research and testing, comprehensive knowledge of state laws and industry codes, and a complete familiarity with insurance company requirements for fabricated piping.

The fabrication of piping for today's high pressure, high temperature or corrosive services is a job for experts. It's a job for Grinnell prefabricating plants because Grinnell has the modern equipment and methods, and the skilled personnel which enable them to assume total responsibility for the job.

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ELECTRICAL EQUIPMENT INDUSTRY GETTING BACK TO NORMAL BUT ON HIGHER LEVEL

INCREASED MANUFACTURING capacity and technical improvements on the production line are sharply reducing abnormal post-war backlog of orders for most types of electrical equipment, according to a speech made recently by Tomlinson Fort, manager of Central Station Sales for the Westinghouse Electric Corp. before the Public Utility Buyers group of the National Association for Purchasing Agents. Delivery time has been cut materially and many types of electrical equipment now can be secured from warehouse stocks. In many ways business is shifting back to a normal basis. However, this shift is being made to a plateau far higher than before.

At the beginning of 1947 the motor manufacturing industry in this country had a backlog of 2,600,000 electric motors of the ordinary factory sizes on order. At the beginning of 1949 this backlog had been cut to 300,000 motors. Delivery dates on large motors for powerhouse auxiliary drives, for example, have been reduced from 20 months two years ago, to 11 months.

Two years ago, distribution transformer shipments were anywhere from ten months to two years. Today this type of equipment is no longer an allotment. Westinghouse now is placing distribution transformers in stock and many standard ratings are available for stock shipment with up to six months shipment for larger and less active ratings. This improvement has been achieved principally by increased manufacturing facilities and increased production to take care of customer requirements.

Distribution transformer production today is more than ten times what it was during the middle of the war and far beyond anything ever expected by the industry only a few years ago.

Current switchgear deliveries should certainly pose no problem to those companies planning expansion programs. At Westinghouse, for example, switchgear manufacturing facilities have been increased by more than 50 per cent. The situation is rapidly becoming one of keeping these facilities loaded rather than one of increasing production.

In the street lighting field, Mr. Fort said, the situation has greatly improved in the past two years. Almost all luminaires, reflectors, and cable are available either from stock or with delivery time of up to eight weeks. Similar conditions exist on watthour meters residential service, relays, and instruments.

Is Your Heating System Adequate and Economical ?

How good is your heating system? Have you checked up on it to see whether a little modernization wouldn't help it? Here are some good practical pointers as to how to go about checking up on your heating plant. Written by a consulting engineer of many years experience in the design and redesigned of heating systems, the suggestions he makes here may save you many hundreds of dollars

By **WILLIAM W. GAYLORD**
Consulting Engineer, Hamden, Connecticut

WAR AND POST WAR conversions have changed location of equipment and the processes carried out in many factories to such an extent that they are now operating under conditions very different from those for which they were designed. In many cases these changes were carried out under such stress that it was impracticable to give much thought as to whether the existing heating system was adequate for and well adapted to the new requirements.

The very large increases in the cost of operating heating systems due to the increased cost of fuel and labor make it more important than ever before that these points be given careful consideration.

The first step is a general survey of the system as a whole to determine whether it is of such design and in sufficiently good condition that it can be made to meet present requirements satisfactorily or whether it will be more economical to replace it in whole or in part by more suitable equipment.

In this survey special attention should be given to the boiler plant and its operating efficiency. If it is found that the boiler units are old, hand fired and of a type unsuitable for conversion to mechanical firing it may well be that the cost of operation is so high that new boiler units mechanically fired will show a large return on the investment even at today's costs.

Where the whole heating system is found to be in poor condition, of obsolete design or totally inadequate for present requirements it may often be more economical to discard it entirely and design a new system suited to present conditions than to try to repair, rearrange and extend present system to meet these conditions. This is especially true where present conditions require much air to be exhausted and no provision for admitting and tempering this air had been provided in the present heating system.

Check Capacities

Where the existing system is found to be in reasonably good condition and to have sufficient capacity so it can be made to meet present requirements the next step is to check the capacities and locations of radiators or heater units in each section against the present heating requirements in that section.

Even where the total capacity of the existing heating units is reasonably close to the present requirements it is often found that the relocation of heat producing equipment or the addition or relocation of exhaust systems has caused local hot or cold spots which are quite troublesome. These can frequently be corrected by rearranging present heater units so the heat distribution will more nearly correspond to present heating requirements.

However where present radiation consists of pipe coils it often proves more economical and satisfactory to replace these with suitable unit heaters which give more control of heat distribution.

Since most heating systems operate at an average load of less than one half their designed capacity some form of effective temperature control is necessary to secure satisfactory results and keep operating costs within reason.

Maybe Automatic Control Will Help

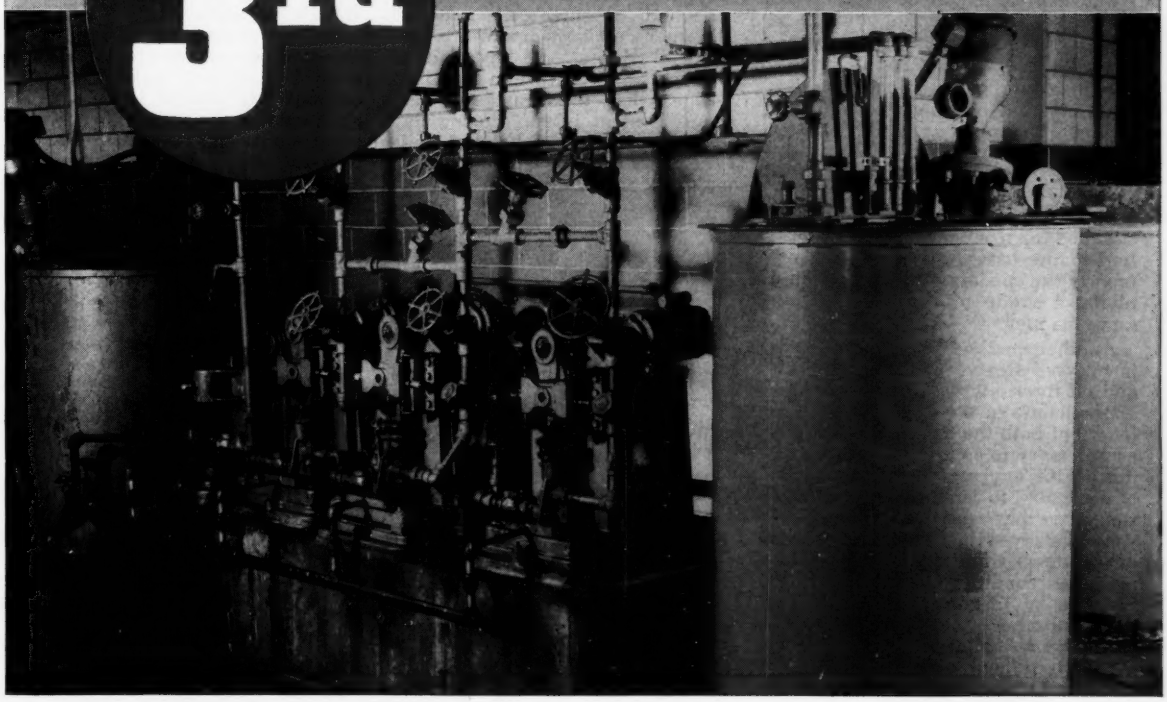
Many of the older heating systems are designed for manual control only and while this can be quite satisfactory if given sufficient attention, experience has shown that this is seldom done. Therefore, if satisfactory results are to be expected, some form of automatic temperature control must be installed.

The objective of this control is, of course, to maintain a comfortable temperature throughout the area to be heated with the least practicable expenditure of fuel. How this temperature control can be accomplished will depend on the type of heating system installed, the amount

BASIC LINES OF DEFENSE IN BOILER WATER CONDITIONING

3rd

THE THIRD LINE OF DEFENSE IS PROPER MEANS FOR TREATMENT APPLICATIONS



Just as Dearborn formulas are "tailor made" to meet specific water conditions, the treatment application system must also be designed to meet plant requirements. Since treatment must be introduced at the proper locations and in proportion to the make-up water used, Dearborn Engineers consider over-all plant conditions before recommending manual or automatic systems for intermittent or continuous feed through the feed-water system or directly to boiler drums.

Dearborn Treatment feeding equipment is designed for all types of plants, for all conditions encountered, from a simple by-pass feeder to systems requiring extreme accuracy in application. Your local Dearborn Engineer will be happy to recommend the feeder system most suitable for your plant.

To establish correct boiler water conditioning, however, all five lines of defense must be given expert consideration.

THE 5 BASIC LINES OF DEFENSE

1. **Adjustment of pretreatment**
2. **Adjustment of internal treatment**
3. **Proper means for treatment application**
4. **Blowdown adjustment**
5. **Test control**

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of ventilation required and the purposes for which the buildings are being used.

Where buildings are heated by unit heaters and there is little, if any, production equipment which either produces heat or requires an exhaust system to remove dust or fumes a very simple control system can be made to give satisfactory results. This would consist essentially of a properly located line voltage thermostat in the power circuit to the motor on each unit heater and either a pressurestat or aquastat at heater, set so fan will run only when heat is required and heater is supplied with steam.

Where buildings are heated by direct radiation or gravity type convectors it is much more difficult to design an automatic control system that will give satisfactory results and still be simple. The usual methods are to vary the pressure of the steam supplied approximately in proportion to the heat output required or to vary the opening of the valve supplying a group of radiators in the same manner.

Another method sometimes used is to have steam supply turned on and off intermittently, varying either the length of the on period or the length of both the on and off periods as necessary to control the heat output. With any of these methods it is necessary to have the piping arranged so that each radiator or convector receives its proper proportion of the steam admitted to the system under all conditions. This is usually done by installing an orifice in the inlet valve or connection to each radiator of the proper size to give the desired heat distribution. Any of these methods can be made to give reasonably satisfactory service if the system is properly balanced when the controls are installed and no changes are made to the system that will upset this balance.

Where it is necessary to exhaust considerable quantities of air to remove dust or fumes an entirely different problem in control is found. In some cases it is found possible to introduce considerable unheated air at the equipment producing the dust or fumes and use this to carry them away without causing discomfort to the operators of the equipment.

Where this can be done a large saving in heat can be made but even under the best conditions some air at room temperature must be exhausted. In many cases, however, the use of unheated air to carry away dust and fumes is impracticable. In some cases it has been possible to filter and recirculate a large part of the air exhausted, but in many others all of the air exhausted together with the heat it carries must be wasted. Where this is the case the air to replace that exhausted must be taken in from outside and heated to or a little above room temperature.

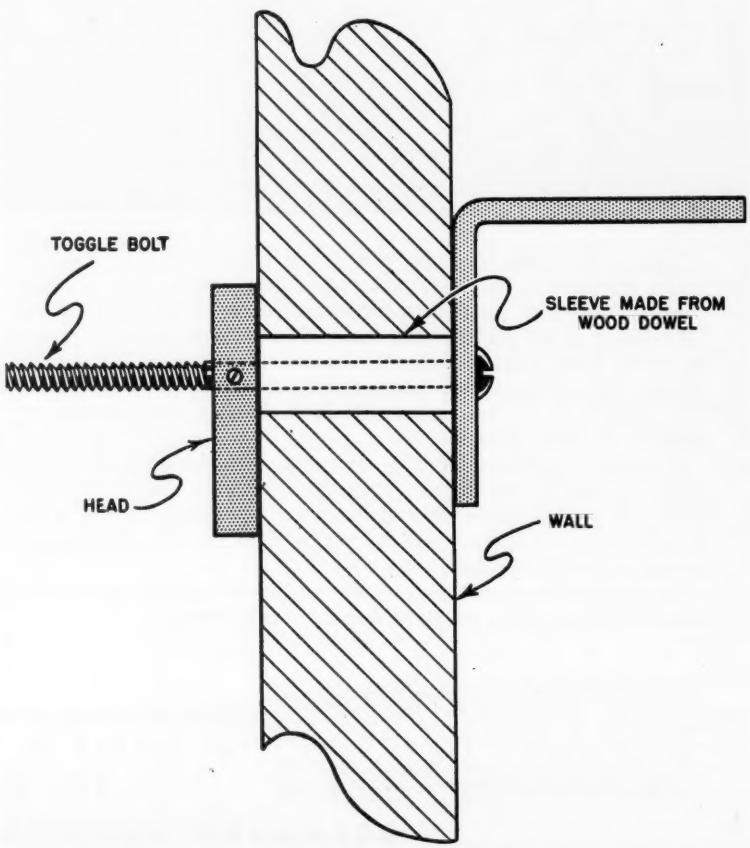
This air is usually heated by unit heaters or blast type heating units arranged to deliver air into the building at the proper temperature. There are two general methods used to control the temperature of the air leaving the heaters. The first is to vary the amount of steam to the heating coils and the second is to vary the amount of air bypassed around the heating coils. The first allows the use of more simple duct work but if it is used a bypass steam connection to heater coils that will open when outside temperature goes below 35 F must be installed or other suitable protection against freezing these coils made. Where exhaust system is run during day shift only, enough of heating units to keep building warm at night should be arranged so the outdoor air supply could be cut-off and these units run to recirculate air in building when exhaust system is not operating.

Regular and systematic maintenance of the heating system is just as necessary as for production equipment if satisfactory and economical operation is to be expected. The fact that many heating systems have operated, after a fashion, for years without any attention does not mean that their operation is satisfactory and economical as a survey usually shows it to be quite the reverse. Where automatic controls are used regular maintenance is even more essential, as even the best automatic control equipment cannot function satisfactorily unless it is kept in good operating condition and proper adjustment, but this will require very little time if regularly attended to.

Make Your Toggle Bolt Solid with a Sleeve

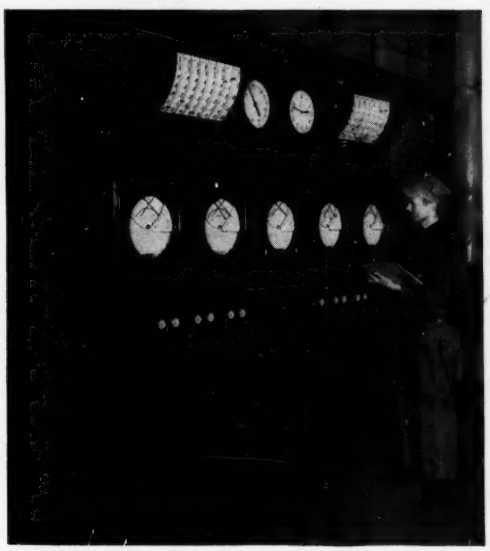
By THOMAS TRAIL

TO PROVIDE a solid fastening when using toggle bolts, a sleeve should be provided to support the toggle bolt where it passes through the wall. A suitable length of the proper diameter wooden dowel rod will serve this purpose excellently since it can be cut to any length.



How to use a piece of wood dowel as a toggle bolt sleeve, to hold everything solid

Loafing Btu's produce no power



Bailey Control on two 65,000 lb. per hour boilers at White Motor Co., Cleveland, Ohio. Day to day evaporation runs consistently above the guarantee.

You find loafers everywhere. Even in a collection of Btu's. You have to *make* them work if you expect to get low cost power. And that is exactly what the Bailey co-ordinated boiler control system is designed to do.

It reduces fuel consumption per pound of steam generated. Combustion, feed water, steam temperature, heater levels, pump speeds and other factors are co-ordinated. Safety of operation is increased—continuity of service is improved. You convert the maximum number of Btu's into power and get all the efficiency your boiler was designed to deliver.

One thing to remember, however, is the fact that this Bailey system is not delivered in a standard package. Each one is designed and engineered to the specific job on which it is to be used. That's *why* it functions so efficiently.

If you are looking for low cost power, it will pay you to call our nearest office.

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The Faith of Jingles Joe

Oscar, the Gas Works Owl, instigates inquiries into problems of boys, girls, dirty water and a bottle of poison—all related to Jingles Joe's greatest ambition . . . Njuneers shud us thr heds, maintains Oscar, bfor shootn off thr mouths . . . This will often keep them from making fools of themselves . . . Also it usually earns Oscar two or three fat white mice

. . . sleeping it off in the coal bunker

By JOHN RAVEN

EVER SINCE I saved his life from a 12 gage shotgun, Oscar the Gas Works Owl has been writing me grateful and pointed letters. He does this by sneaking into the office where he upsets my India ink bottle and then scrawls what he has to say by dipping his claws into the mess.

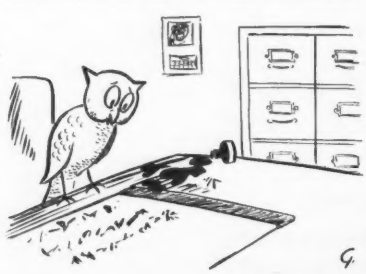
For instance, I came into the works one morning determined to tell my Boss that 3 years without a raise or at least a promotion was too long, and that such disesteem of my talents must be severely punished. In fact, I intended to get rid of him. My resignation was in my pocket.

And on that morning, here is the kind of owlish wisdom that greeted me:

u njuneers (I read in the hen-tracks that decorated the cover sheet of my drawing board) caws plenty of trubl b caws u shoot off ur mouths b4 u use ur heds now u better go c jingels jo b4 it is 2 late

Jingles Joe is a fireman in No. 2 boiler house and at the same time a No. 1 dope. He got his name 10 years ago when somebody as a joke told him to start talking in rhyme because that would put him into the proper rhythm to father a son, and he is so crazy to have a son that he has been talking that way ever since. In fact, when the doctors told him he couldn't even father a cat, on account of there being a lost chord somewhere in his family, he advertised for its return and even offered a reward.

And now, according to Oscar, Jingles Joe has been lapping up dirty water for nearly a year, straight from the artesian well that we use for boiler make-up. He got the idea from his chief, who claimed it was the cause of his own six kids, the liar, said Oscar. And of course



. . . hen-track messages on the drawing-board cover or desk blotter

Jingles and his wife not only drank it, they washed in it, cooked with it, and maybe slept in it, although Oscar admitted he had never seen it splash out of the bed.

but ystrday (Oscar's message concluded) jingles jo stopt drnking th watr insted he is drnking stuf frm a botl that burnd my stumic when i tryd it so whatevr hapens now is ur falt urs n gratetud cs all n nos all oscr th gas wrks oul

I knew the time had come to act; 25 years of continuous disappointment is too much for any man. We once had a plumber crawl into a purifier bed merely because his wife ran off with a brush salesman.

. . . the chief sound asleep as usual

When I got to boiler house No. 2 there was no sign of Jingles Joe, the chief, or anybody else. The boilers were tending themselves with the stokers squealing and groaning except for No. 4 boiler where a shearing pin had let go.

I found the chief in his office with his big feet on his desk and his eyes closed.

"I ought to fire you right now," I yelled. "Where's everybody? Where's Jingles Joe? Don't you know maybe he's dead because you told him to drink that darned water?"

"I don't know nothin'" said the chief, "except I bin workin' for you like a dog, five years straight come tomorrow. And do you care? Do you get me a raise? No! You don't even give me a good word. If you wanta fire me, go ahead. I figured I'd quit anyhow."

It sort of took me in the wind, because maybe I had been neglecting the people in my department, but this was no time, I said, to discuss it. Instead, I told the chief to stick a new pin in No. 4 stoker and then start looking for Jingles Joe, whose life was being dissolved more every minute by a bottle of poison. It wasn't liquor, I knew, because old Jingles was a teetotaler.

"And you'd better telephone the doctor, too," I added, "because with poison, time is everything."

The only trouble was, we couldn't find Jingles. We looked everywhere, including the rubbish can and the broken floor under the toilet, but the pale eyes and drooping mustaches that we knew so well, had certainly picked out a mighty secret hole in which to die.

"Gee," said the chief, sweating, "I didn't think he'd take that water gag so seriously."

"Engineers," — I couldn't resist quoting Oscar,—"cause trouble by shooting off their mouths before they use their heads. No wonder engineers don't get raises."

"Yes sir," said the chief, humbly.

The doctor came in carrying his little black bag and a load of excitement.

"Suicide! In the gas works, too! Tsk! Tsk!" He rolled his eyes. "Hanging is so gruesome. Why didn't you cut him down?"

'We can't find him," I said, "and it's not hanging, it's poison."

"Then whose foot is sticking out over the coal bunker?"

Old Jingles was stretched out on the coal, flat on his back and groaning. I pushed back his cap from where it had slid down over his yellow mustaches, and tried to open his mouth, having heard somewhere to do that in poison cases. The smell of the stuff—I could see the bottle lying partly under him—was nauseating.

"I'll take him in a minute," said the doctor behind me. "Climbin' that ladder's got me winded."

"I'm finished," moaned Jingles, stirring a little. "I'm dyin' and goin' to hell. The chief said that damn water would gimme a boy. And he lied. It's no damn good."

"I'm sorry," said the chief. "It was a joke."

He dropped a fat and remorseful tear into the coal.

"It was a dirty trick," Jingles mumbled. "I started drinkin' this stuff in the bottle last night, the minute the doctor told me that damn water had gimme a girl. It's the worst whiskey I could buy. I got cigars, too. They're in my coat."

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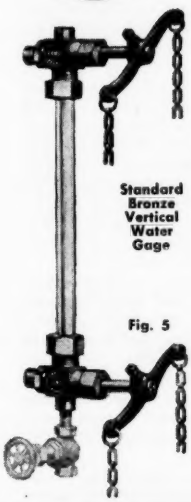

Standard Bronze Vertical Water Gage

Fig. 5

Fig. 1-G

Split-Gland water gage can be set Vertical or Inclined

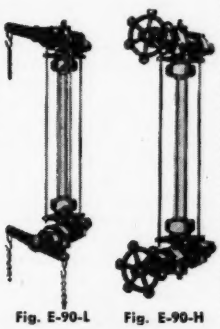

Fig. E-90-L Fig. E-90-H

Lever and Hand Wheel Type Forged Steel Gages

Water Columns high and low alarm

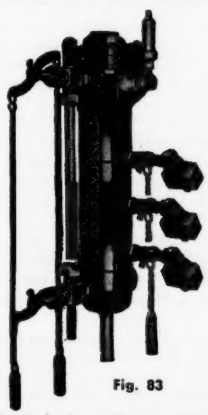

Fig. 83

High & Low Alarm Column with Vertical Gage and DCP Weighted Type Try Cocks

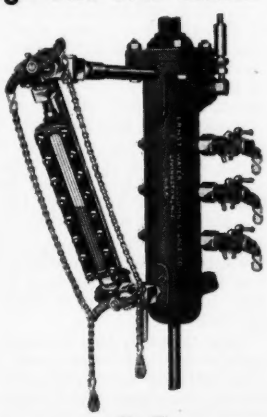

Fig. 32

Column Equipped with Inclined Prismatic Reflex Insert and Series 450 Try Cocks

SPECIAL WATER COLUMNS GAGES AND COCKS TO SPECIFICATIONS

illuminators

"PLAIN SIGHT" NON-GLARE

gage glass guards

PLASTIC NON-BREAKABLE

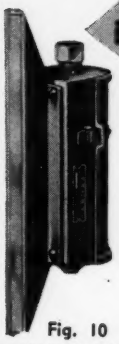

Fig. 10

Fig. 31

TRY COCKS

LEVER & WEIGHTED TYPE FOR ALL TYPES OF BOILERS

Fig. 13

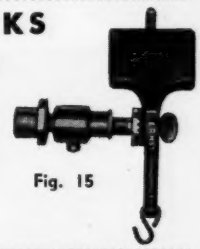

Fig. 15

SIGHT FLOW INDICATORS

for insertion into pipelines

Fig. E-57 Bulls Eye Type

Fig. 17-28 Tubular Glass Type

Fig. E-811 Flapper Type

HIGH PRESSURE

GLASSES AND GAGE GLASS GASKETS MANUFACTURED IN ALL SIZES TO FIT YOUR WATER GAGES

Fig. 14

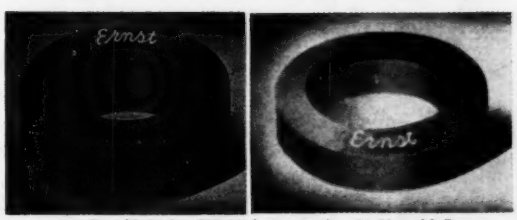

Fig. 22 Series 750, Std. Patt. Fig. 21 Lipmold Type

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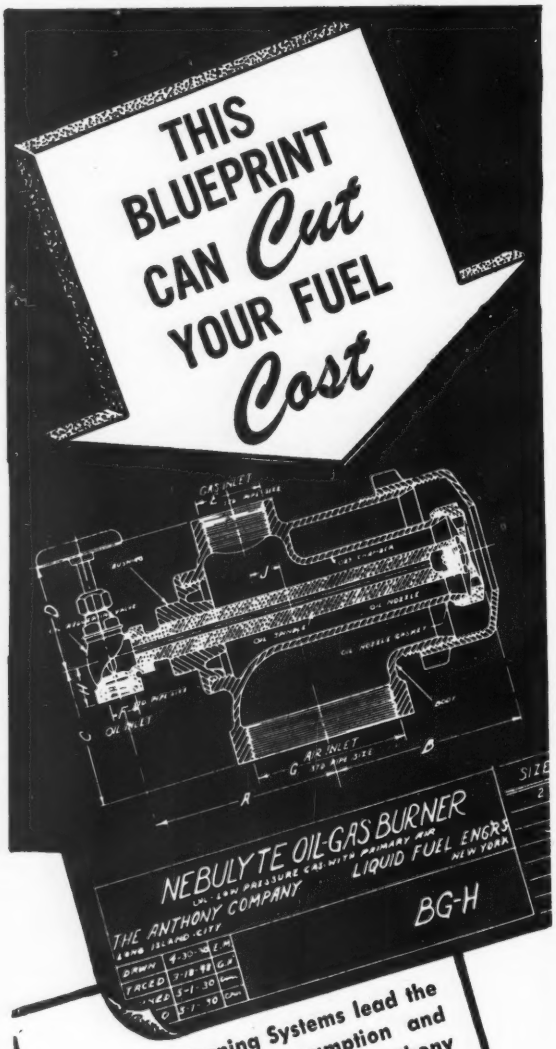

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POWER PLANT Construction News

Bellevue, Neb.—Loup River Public Power District, Columbus, Neb., has preliminary plans under way for new steam-electric generating station in vicinity of Bellevue, reported to cost approximately $3,000,000, with turbine-generator, high-pressure boiler and auxiliary equipment.

Brooklyn, N. Y.—Consolidated Edison Co. of New York, Inc., 4 Irving Pl., New York, N. Y., has plans under way for new power plant on site in Brooklyn, reported to cost over $2,500,000. Project is scheduled to be carried out at early date.

New York, N. Y.—Staten Island Edison Corp., 50 Bay St., Staten Island, New York, plans a 36-month expansion and improvement program in plants and system, extending into 1952, including increased generating capacity, power substations, transmission lines and other facilities. Cost estimated close to $9,000,000.

Roanoke Rapids, N. C.—Virginia Electric & Power Co., Richmond, Va., plans new hydroelectric generating plant on Roanoke River, near Roanoke Rapids. Estimates of cost are being made. It is understood that this is part of 1950 expansion and improvement program of company.

Woodward, Okla.—Western Electric Cooperative, Inc., Woodward, has approved plans for new generating station on local site, using Diesel engine-generator units and accessories. No estimate of cost announced. Work is scheduled to begin soon on construction of station building.

Charleston, S. C.—South Carolina Power Co., Charleston, has arranged appropriation of about $8,600,000, for expansion and improvements in power plants, power substations, transmission lines and other facilities, including work now in progress. Program will carry through into 1950.

Longview, Texas—Southwestern Gas & Electric Co., Shreveport, La., has completed plans for new steam-electric generating plant in vicinity of Longview, estimated to cost about $5,000,000, and will begin work on superstructure at early date.

Phoenix, Ariz.—Central Arizona Light & Power Co., Phoenix, will carry out expansion and improvements in power plants and system during 1950 to cost close to $9,500,000, including increased generating capacity, power substations, transmission lines and other operating facilities.

Imperial, Calif.—Imperial Irrigation District, Imperial and El Centro, Calif., plans expansion in power plants and system to cost about $12,500,000. Bond issue in that amount has been authorized. Program will be carried out over period of months, and will include increased generating capacity, transmission lines and other work.

Argo, Ill.—Corn Products Refining Co., 333 North Michigan Ave., Chicago, Ill., has completed plans for new power house at plant at Argo, reported to cost about $3,000,000, with equipment. Work on building is scheduled to begin at once. Sargent & Lundy, 140 South Dearborn St., Chicago, are consulting engineers.

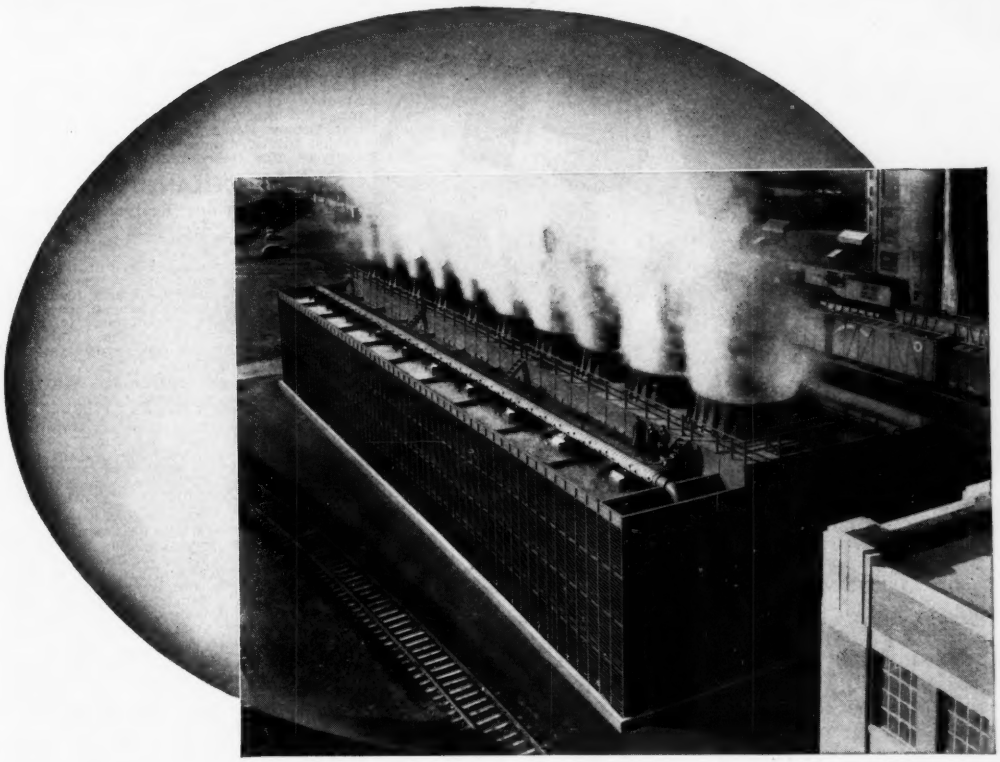
Council Bluffs, Iowa—Iowa Power & Light Co., Des Moines, Iowa, is reported planning new steam-electric generating station in vicinity of Council Bluffs, to cost close to $5,000,000, with turbine-generator, high-pressure boilers and auxiliary equipment.

New Orleans, La.—Louisiana Power & Light Co. has plans under way for new steam-electric generating station on tract of land near city, fronting on Mississippi River, recently acquired. Cost reported over $8,000,000, including transmission lines, power substations and other operating facilities.

Somerset, Mass.—Montaup Electric Co. has approved plans for enlargement of local steam-electric generating station, with installation of new turbine-generator, high-pressure boilers and auxiliary equipment. Entire project will cost approximately $13,000,000, and will be carried out over period of months. Work on building will begin soon. Stone & Webster Engineering Corp., 49 Federal St., Boston, Mass., is consulting engineer.

Ypsilanti, Mich.—State Building and Construction Division, Lansing, Mich., has plans under way for new power plant for lighting and central-heating service at State Normal College, Ypsilanti. Cost estimated about $1,000,000. Proposed to ask bids late this year or early in 1950.

Double-Flow MARLEY Double Efficiency



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Only Double-Flow Cooling Towers offer outstanding, exclusive features such as:

1. **OPEN DISTRIBUTION SYSTEM** . . . On top of the tower, in plain view, easy to inspect, regulate and clean.
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6. **MINIMUM DRAFT LOSS** . . . Drift eliminators set in slanting position allow greater area for air passage, minimizing draft loss and reducing horsepower requirements.
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If you want to improve water cooling efficiency and reduce water cooling costs in your plant, it will pay you to ask a MARLEY "Double-Trained" Application Engineer to tell you all about the DOUBLE-EFFICIENCY of the MARLEY DOUBLE-FLOW. No cost or obligation.

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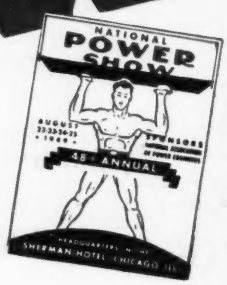

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AUGUST 22 thru 25

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Only a few more days . . . only a few more exhibit spaces . . . until your 1949 opportunity is gone . . . meet and sell the men who specify or buy steam and power generation, compressed air and materials handling equipment and supplies. Ask about FREE space for educational exhibits . . . FREE space to hold your own clinic . . . FREE space for film projection facilities.

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- **Plan now to attend the show! Pack your notebook and be ready to jot down data on the latest developments in your own field.**
- **See you in Chicago . . . at the Hotel Sherman . . . at one of the greatest Power Shows in history!**

These famous names in the power field are among the exhibitors who made early reservations for space at the 48th Annual Power Show

Airetool Mfg. Co.
Alken-Murray Corporation
American Structural Products Co.
Apex Engineering Co.
Armstrong Machine Works
Babcock & Wilcox Co.
Barrett-Christie Co.
Brooks Boiler Treatment Co.
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Combustion-Engineering, Superheater, Inc.
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Dowell, Inc.
Electric Auto-Lite Co.
Fairbanks, Morse & Co.
Flynn & Emrich Co.
Garlock Packing Co.
Graton & Knight Co.
Green Fire Brick Co.
Henricksen, C. O. Co.
Hills-McCanna Co.
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Livingston Engineering Co.
Lowden & Company
Louis Allis Co., The
Lunkenheimer Co.
McNeill-Engineering Co.
Mason-Neilan Regulator Co.
Matalock Repair Service, Inc.
National Aluminate Corp.
Nevins, W. P. Co.
Nordberg Manufacturing Co.
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Perfex Corporation
Plibrico Jointless Firebrick Co.
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Shallcross Controls
Shell Oil Co.
Southern Coal Co., Inc.
Standard Oil Co. (Indiana)
Strong, Carlisle & Hammond Co.
Trostel & Sons, Albert, Co.
Vickers, Inc.
Walworth Co.
Winger Construction Co., The
Wright Chemical Co.

HELPFUL BULLETINS

(Continued from page 36)

Liners and Grates." It recommends the alloy steels and irons best suited to meet different impact and abrasion conditions existing in grinding mill installations. These alloys, their characteristics and uses, are described in detail with charts and pictures. Manufacturer's work in developing testing procedures to study abrasion resistance and toughness of alloys is discussed. American Brake Shoe Co.

131 **Stainless Steel Tubing** — Technical Data Card 122 gives standard type numbers, chemical composition limits and range of many of manufacturer's stainless Croloy steels used in seamless and welded tubing, ranges being based on ladle analyses. The Babcock & Wilcox Tube Co.

MISCELLANEOUS

132 **Coal Handling Equipment**—"Scientific Coal Preparation Methods and Equipment" is the title of 28-pp Book 2355, covering a series of ads featuring manufacturer's equipment used in mining operations. They contain many installation views, flow sheet diagrams and ideas for low cost handling and better preparation of coal at the mine. Equipment featured includes oscillating conveyors, vibrating screens, car dumpers, conveyor systems, dryers. Link-Belt Co.

133 **Packing Selection Data**—Materials of construction and packing materials for use with over 300 industrial liquids and gases are listed in manufacturer's revised Catalog Section 97, 4 pp. This tabulation of corrosion-resistant materials is based on previously published data, complemented by company's broad experience in handling corrosive fluids. Fischer & Porter Co.

134 **Steam Generating Equipment**—Bent-tube and straight-tube boilers of several classes are described in detail and illustrated by photos and drawings in this 4-pp bulletin. Also illustrated are some of the valves, heat transfer equipment and refrigeration equipment manufactured by company. Henry Vogt Machine Co., Inc.

135 **Economical Vibration Control** — A low cost cork and rubber mounting requiring no bolting or cementing for most applications and providing an efficient means of controlling transmission of vibration and noise is described in Bulletin ER-701, 4 pp. Methods of installation are described and illustrated; and the resiliency, damping factor and sound insulation qualities of this material are compared with those of other insulating materials. Three types of damper are also described. Korfund Co., Inc.

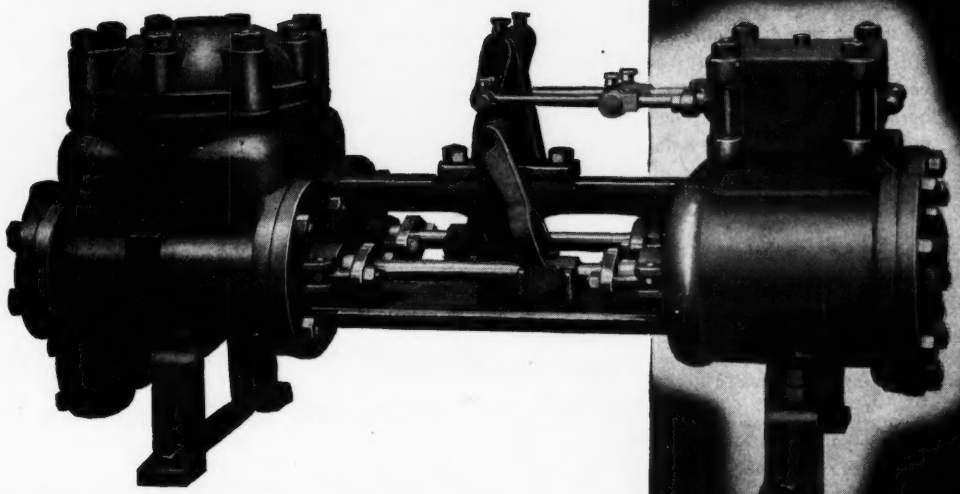
136 **Dessicant-Bed Drying**—Catalog D-27, 32 pp, on dryers covers basic principles and specific factors affecting the dynamic drying of air, compressed air, a wide range of gases, and various liquids including animal and vegetable oils, butane, distillate fuel oil, freon and gasoline. General operation of a dryer is explained and illustrated by cutaway drawings showing the drying cycle (in which gas is dried by passing through the dessicant bed) and reactivation (in which adsorbed moisture is removed from the dessicant to prepare it for a new drying cycle.) Schematic drawings in color show how both temperature and pressure of gases entering dryer affect size of equipment required for a specific process. Selection charts enable quick determination of size required for a given job. Catalog lists 26 variable factors which must be considered to insure a dryer designed for the task it must accomplish. Kemp Mfg. Co.

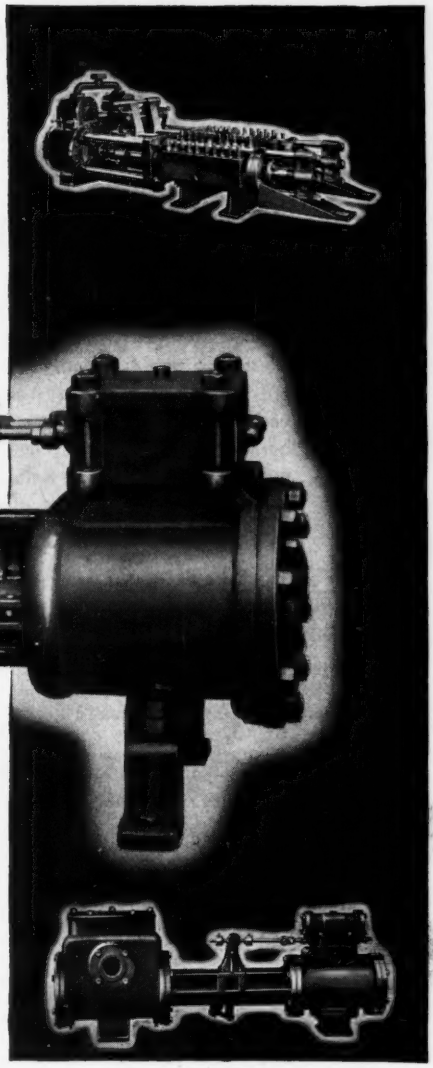
137 **Purger Bulletin**—How air and other non-condensables get into refrigeration systems; the adverse effect of this on operating costs and efficiency and what manufacturer's forged steel purger does to prevent it are covered in 8-pp Bulletin 192. Also included are installation data with illustrations and diagrams, specifications and prices, helpful charts and tables. Amstrong Machine Works.

138 **Miniature Speed Changer**—One-pp Bulletin 99 gives operating principles, applications and design features of a variable-ratio speed changer weighing less than 6 oz. Includes actual size photo, dimensional sketch, specifications, price. Metron Instrument Co.

139 **Flooring Guide**—Pictures and text in this 8-pp pocket-size folder tell how aircraft, railroad, marine and other industries are meeting floor repair and resurfacing problems with an economical and durable flooring applied over concrete, brick, stone, composition, steel or wood floors. Chart shows standard mixes. Flexrock Co.

NEED A *Reciprocating Pump?*





Let WARREN put a dependable, high performer on the job . . .

SELECT FROM THESE:

- Horizontal and Vertical single piston
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- Steam Heat Vacuum
- Automatic Pump and Receiver, etc., etc.

Satisfaction guaranteed . . . by one of the country's largest *exclusive* pumpmakers, by long and specialized application engineering, by craftsmanship from conscientious workmen.

Warren speaks your language. Tell us of your problem and get a good, sound recommendation.

WARREN CENTRIFUGAL PUMPS

Single and multi-stage
Pressure range: 0 to 1200 P. S. I.
Capacities: 5 to 50,000 G. P. M.
Types: Horizontal and Vertical
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P-19

WARREN STEAM PUMP COMPANY, INC. SERVICE EVERYWHERE **WARREN, MASS.**

WARREN PUMPS

CENTRIFUGAL AND RECIPROCATING

For: Power Plants · · · Chemical Plants · · · Paper Mills · · · Food Industries · · · Metal Working · · · Oil and Mining Services

FOR THE DIESEL OPERATOR

What the Dual-Fuel Engine Can Do

It can burn either gas or oil, converting from one to the other manually or automatically . . . In less than 4 yr, a number of American builders have applied large numbers of gas-Diesel and dual-fuel engines in municipal and industrial plants, sewage plants, oil field drilling . . . Anywhere gas is available, engine finds application, burning oil if gas supply varies or fails . . . When burning gas, small amount of oil provides ignition, the fuel burning on the Diesel cycle . . . Various society papers show how gas and pilot oil are supplied to engine . . . Relative costs of oil and gas fuels and savings as compared to full oil operation . . . Details of typical installations . . . Existing Diesels may be converted

OF ALL THE engine developments of recent years, none has been so timely and so quickly accepted by the field as the dual-fuel Diesel engine and the gas-Diesel. Increase in availability of gas in many parts of the country and increased cost of oil in some cases have led to increased interest in these engines. True there has been some variation in oil prices—in some locations a considerable reduction—but, on the whole, changes in the prices of fuels will probably not materially retard the dual-fuel development.

The engine was developed to meet the desire for burning all gas available, or oil when necessary, or when price fluctuations make it advantageous, changing over from one fuel to the other very quickly and in some cases, as explained below, automatically.

What is a Dual-Fuel Engine?

Assuming that everyone is familiar with the general principles, and construction features of heavy-duty, Diesel oil engines, several speakers before the SAE in Detroit, the 11th Midwest Power Conference and the ASME Oil and Gas Power Conference at Chicago in April, discussed various aspects of the new engine. Installations of these have been made by several manufacturers, who have devoted much research work to their development. Most of the engines are 4-cycle, although some companies have also done much work with the 2-cycle engine.

According to DEMA, a dual-fuel engine is an engine that operates on all oil fuel on the Diesel cycle, or predominantly on gaseous fuel with oil ignition, and is fully convertible from one to the other. On the other hand, a gas Diesel is essentially a dual-fuel engine that is not immediately convertible. The primary difference between the two, therefore, is in parts of the oil fuel injection system.

When the engine is burning gas, the gas fuel is admitted by methods discussed below, a small amount of oil fuel is injected at the high compression point and the ignition of this oil fuel, just as in the Diesel, in turn ignites the gaseous fuel, which burns on the Diesel cycle. The small amount of fuel oil, usually about 5 per cent of the total fuel requirement, performs the function of igniter in the same way that a spark plug would in a spark-ignition gas or gasoline engine.

Discussing these points before

Figures 1 and 2 for Fairbanks, Morse & Co. engines, from paper on the Two-Cycle Dual-Fuel Engine with Automatic Fuel Conversion, by Conn, Beadle and Schauer; ASME Oil & Gas Power Conference, Chicago, April 1949. Figures 3 to 10 inclusive from paper Status of Dual-Fuel Engine Development, by Ralph C. Boyer, vice president and chief engineer, The Cooper-Bessemer Corp. before SAE Annual Meeting, Detroit, January 1949, reproduced from *Diesel Power*.

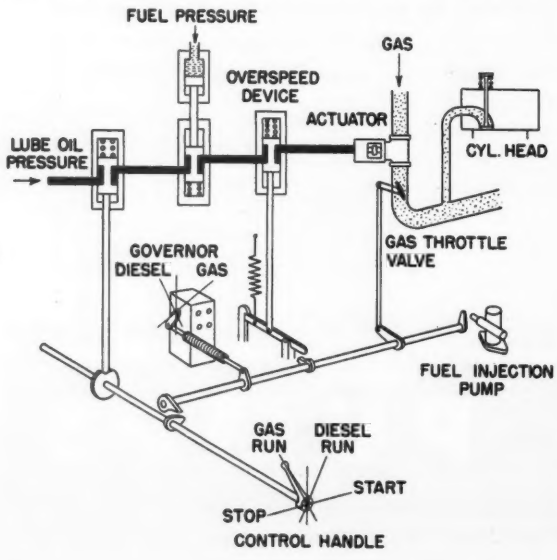


Fig. 1. (Left) Governor system for 2-cycle dual-fuel engine

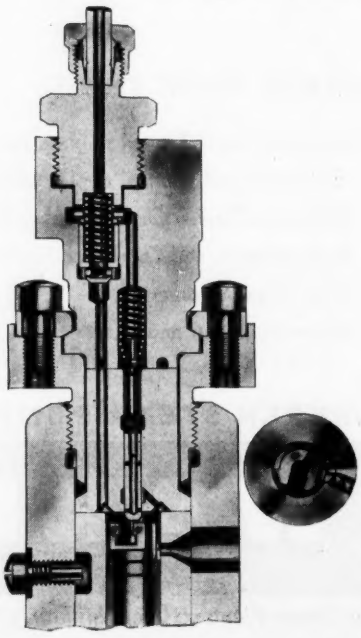
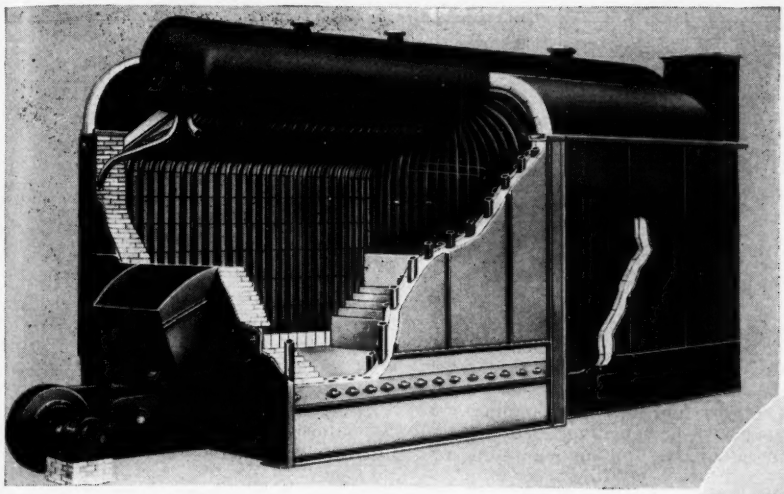
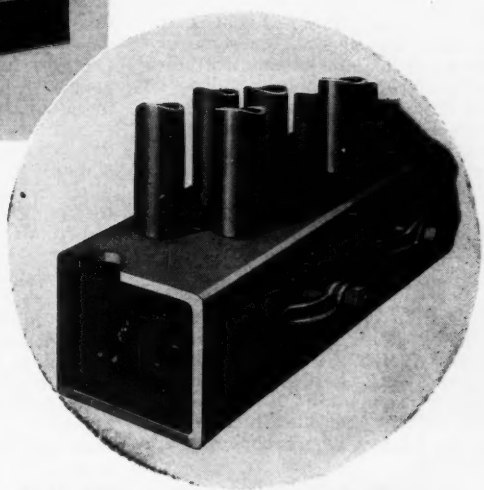


Fig. 2. (Right) Fuel-pump for 2-cycle dual-fuel engine is a duplex type, with separate injection pump plunger for pilot oil injection mounted on top of regular Diesel injection pump plunger. Both plungers, and the gas admission valve, actuated from a single cam shaft

TYPE-VL *A Low Headroom*
2-DRUM WATER WALL BOILER



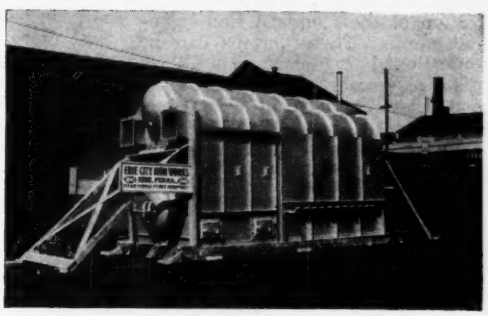
SHIPPED BUILT-UP IN SIZES TO 300 H. P.



Water Wall tube arrangement—1 Downcomer for each 2 Riser Tubes

Clean, Quiet, Circulating Water Taken From Top Drum

BACKED by a long experience gained in the manufacture of over 500,000 H.P. of Erie City 2-drum water tube boilers and of thousands of complete built-up boiler units, Erie City has incorporated side wall water cooling as an integral part of a low headroom 2-drum boiler. Outstanding of many features, is the method of obtaining a ring flow circulation, in each side wall element. A downcomer tube is provided for each pair of radiant (riser) tubes in the side wall, which, with two front wall downcomers assure an ample supply of clean circulating water in the water walls at all times. Insulation between riser and downcomer tubes keeps water at lower temperature in the downcomers while heat is rapidly removed from refractory through risers. Write for VL bulletin that clearly describes and illustrates this and many other features.



Shop assembled and shipped as a unit in sizes to 300 H. P.

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ERIE CITY

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ERIE CITY IRON WORKS • ERIE, PA. • *Since 1840*

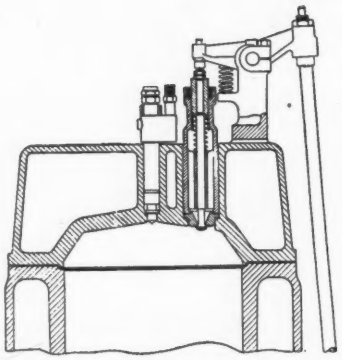


Fig. 3. Low-pressure gas injection for 2-cycle gas-Diesel engine

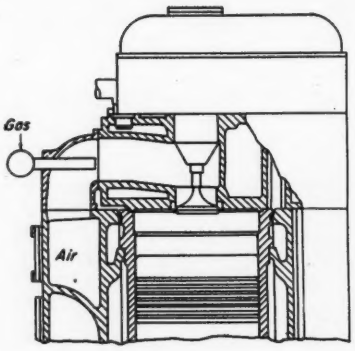


Fig. 4. Method of gas intake for atmospheric 4-cycle gas-Diesel

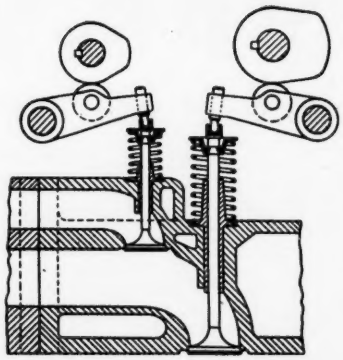


Fig. 5. Principle of timed gas injection for supercharged 4-cycle engines

MPC, George Steven, executive engineer, Worthington Pump & Machinery Corp. explained that in the non-supercharged engine some designers utilize one gas control valve and balance gas supply to individual cylinders by manually adjusted cocks at each cylinder. Others use timed gas injection, admitting gas to the intake ports somewhat later than opening of the inlet valves and after the overlap period between inlet and exhaust. The Worthington engineers have leaned to the second view, feeling it has a slight advantage.

Where conversion of an existing installation of an oil Diesel engine is being considered, the single gas control valve, with mechanically adjusted cocks between each cylinder and gas manifold is the cheapest arrangement, and one which Worthington follows where conversion is involved.

Liquid Fuel Injection

For liquid fuel injection, on a gas Diesel unit, suitably-sized fuel pumps can be located in the normal position of the standard fuel injection pumps. These pumps can be proportioned to inject a small pilot quantity, possibly in the neighborhood of 5 to 7½ per cent of total fuel requirement.

The full diameter plungers necessary for full Diesel oil operation, said Mr. Steven, are difficult to calibrate for the small injection quantities and obtain reliable and most efficient operation.

These fuel injection pumps are generally, however, sufficiently large to adequately handle operation on straight fuel oil in the event of a gas failure to approximately 50 or 60 per cent of normal full load operation. Some builders do use full size fuel pumps for small pilot quantity, but from their own observations, reliability is improved by the use of smaller diameter plungers and they prefer such an arrangement.

In the dual-fuel engine, where operation on 100 per cent liquid fuel or gas with pilot ignition or any quantity of either is desired, the liquid fuel injection problem changes. At first, said Mr. Steven, they provided a separate injection system for the pilot oil only, maintaining the main liquid fuel injection system as it already existed. But this equipment was all in addition to the main fuel pumps, fuel lines and full-size injection nozzle and cost more.

Worthington engineers finally developed a new type of dual-plunger pump. In this pump, a small diameter pilot plunger is mounted non-rigidly to the main pump plunger. The two plungers are operated by the governor, through suitable cams and racks, in such a way that for pilot operation, the pilot plunger delivers the required amount of oil.

For full load oil operation, the mechanism causes the main pump plunger to deliver full capacity plus the capacity of the pilot plunger. The total fuel displacement of the pilot pump plunger when operating in conjunction with the main pump is less than the fuel necessary to maintain maximum speed with no load.

Thus one pumping unit has the desirable qualities necessary for both pilot oil requirement and full Diesel oil requirement without compromise in either case.

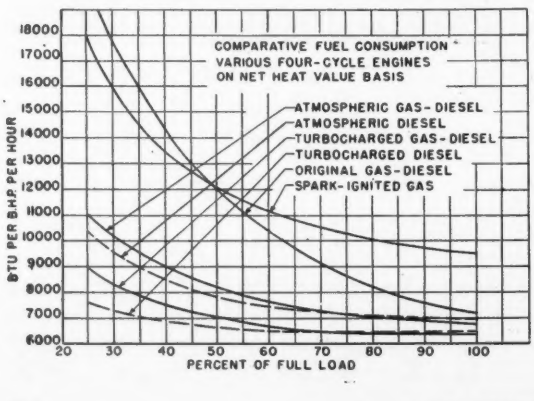
Gas Injection in Supercharged Engine

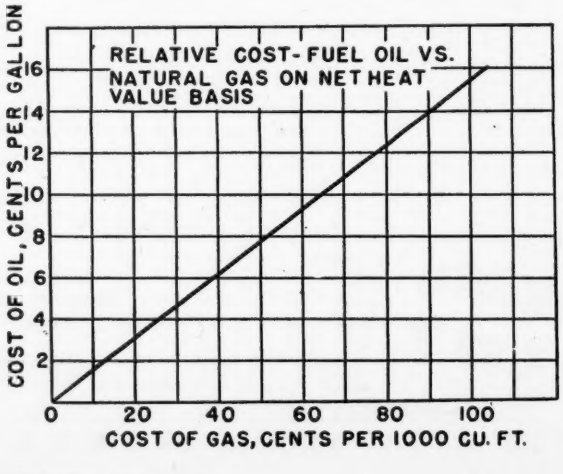
In the supercharged gas Diesel or dual-fuel engine, it becomes necessary to inject the gas into each cylinder at a timed position. Beginning of injection usually takes place immediately after the exhaust valve has closed.

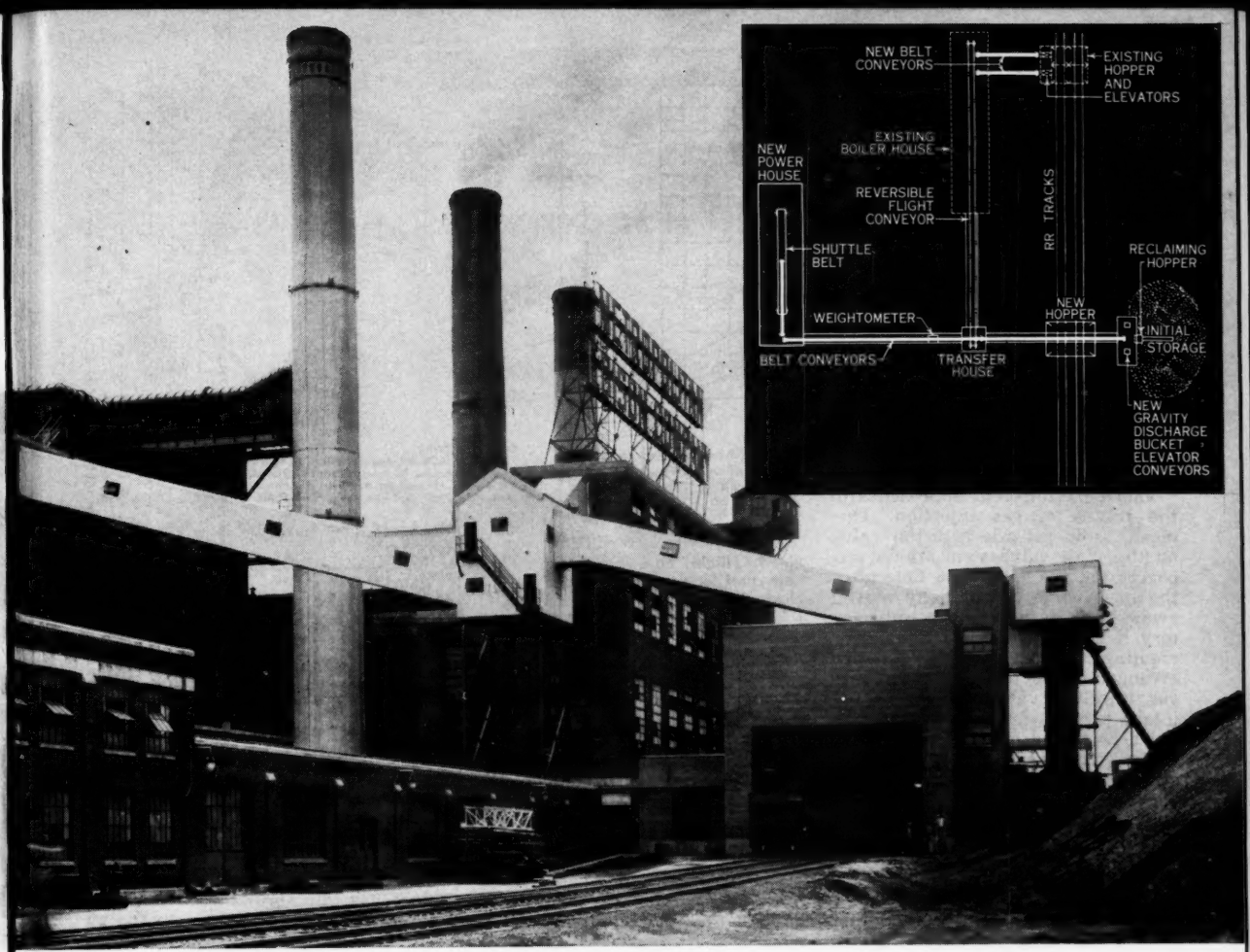
Considerably greater overlap between inlet valve opening and exhaust valve closing on a supercharged engine exists than in a non-supercharged engine. This overlap provides the necessary time for scavenging air to be blown through the exhaust valves, thereby reduc-

Fig. 6. (Below) Fuel consumption rates for 4-cycle engines

Fig. 7. (Right) Relative cost of fuel oil vs natural gas







Above: Power plant of Metropolitan Edison, equipped with Link-Belt coal handling machinery from track hoppers to bunkers, also to and from outside storage.

Link-Belt Belt Conveyors *integrate the old and the new*

at Metropolitan Edison Station, Middletown, Pa.

Increased load demand often necessitates the addition of generating capacity housed in a new plant adjacent to existing facilities. This sets up the problem of integrating the coal handling to bunkers of both old and new boilers.

Gilbert Associates, Inc., Reading, Pa., have solved this problem at the Crawford Station of the Metropolitan Edison Company by the use of Link-Belt belt conveyors and auxiliary equipment, handling coal at 300 T.P.H.

New equipment consists of track hopper, with feeders, gravity discharge elevator conveyor; with which coal from the latter is discharged to the initial pile to form ground storage. The coal is reclaimed through a reclaiming hopper, feeding back to a crusher. Coal from the gravity discharge elevator is carried by a belt conveyor to the transfer house, from where it can be taken up to the new power house by means of a belt conveyor and distributed there by a shuttle conveyor. Or it can be delivered from the transfer house by a reversible flight conveyor to the existing boiler house. Normally the new conveying system handles coal to both old and new power houses; but in case of emergency the old hopper with feeders and two elevators can be used. Two new short belt conveyors can feed to the new reversible flight conveyor. The old equipment is used as standby. (See diagram sketch). We'll be glad to give you more details.

TYPES OF LINK-BELT CONVEYING MACHINERY

Belt Conveyors	Oscillating Conveyors
Screw Conveyors	Apron Conveyors
Bulk-Flo Conveyors	Flight Conveyors
Chain Conveyors	Bucket Elevators
Trolley Conveyors	Bucket Carriers

LINK-BELT COMPANY Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Dallas 1, Houston 3, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8. Offices in Principal Cities.

11.304

LINK-BELT

CONVEYING MACHINERY

"THE COMPLETE LINE"

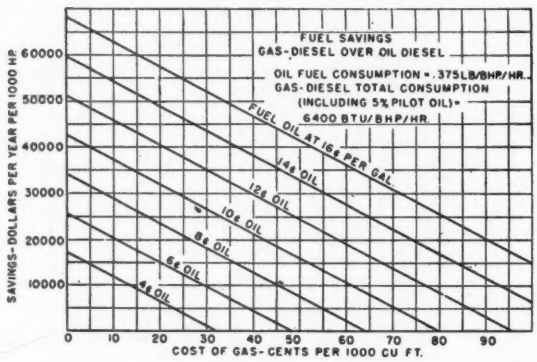


Fig. 8. (Above) Fuel saving of gas-Diesel over oil-Diesel

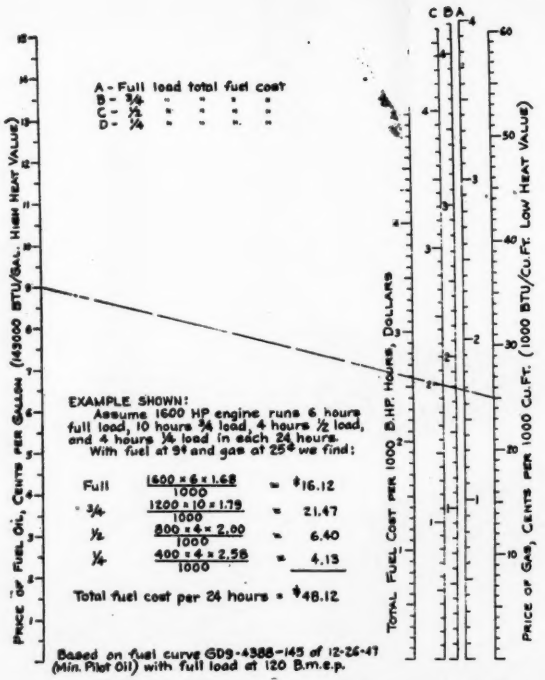

A - Full load total fuel cost
B - ¾ " " " "
C - ½ " " " "
D - ¼ " " " "
EXAMPLE SHOWN:
Assume 1600 HP engine runs 6 hours full load, 10 hours ¾ load, 4 hours ½ load, and 4 hours ¼ load in each 24 hours.
With fuel at 9¢ and gas at 25¢ we find:
Full 1600 x 6 x 1.68 / 1000 = $16.12
¾ 1200 x 10 x 1.79 / 1000 = 21.47
½ 800 x 4 x 2.80 / 1000 = 6.40
¼ 400 x 4 x 2.58 / 1000 = 4.13
Total fuel cost per 24 hours = $48.12
Based on fuel curve GD9-4388-145 of 12-26-47 (Min. Pilot Oil) with full load at 120 B.m.e.p.
PRICE OF FUEL OIL, CENTS PER GALLON (143000 BTU/GAL. HIGH HEAT VALUE)
TOTAL FUEL COST PER 1000 B.HP. HOURS, DOLLARS
PRICE OF GAS, CENTS PER 1000 CU.FT. (1000 BTU/CU.FT. LOW HEAT VALUE)

Fig. 9. (Right) Fuel cost chart for supercharged 4-cycle gas-Diesel at various loads

ing the overall cylinder head operating temperature.

There are different approaches to the means of gas injection. One means is to provide a piston valve on the inlet valve stem which uncovers the gas port some time after the inlet valve has actually moved away from its valve seat—satisfactory if gas pressure is available for creating required gas flow. Another arrangement is to have a separate gas injection valve located in the intake port or directly into the cylinder itself and operated separately by its own actuating cam, push rod and lever. This permits a longer opening period for the valve, enabling the required gas quantity to be admitted to the combustion space with lower gas pressure. This is quite important in some locations, particularly in sewage disposal plants where the gas is generated at very low pressure.

Governing

In the automatic arrangement, after the gas control valve has opened to its maximum extent and the gas is insufficient to maintain full load, the fuel pump will automatically become operative and supply the necessary fuel for maintenance of full load operation.

Table showing record of 3 years' operation of an atmospheric (non-supercharged) 4-cycle gas-Diesel engine

SULPHUR SPRINGS VALLEY ELECTRIC CO-OP.
McNEAL, ARIZONA POWER PLANT

COOPER-BESSEMER IS-8-GAS DIESEL
8 - CYLINDER - 15-1/2" x 22"
ENGINE RATING - 975 BHP at 327 RPM at 4160 FT. ELEVATION
GENERATOR RATING - 685 KW at 0.8 PF

Gross Engine Hours	24,409
Gross KWH Generated	19,069,000
Average Gen. Load KW	780
Average Engine Load BHP	1,111
Lube Oil Consumption Gal.	4,887
BHP-Hours/Gal.	5,550
FUEL CONSUMPTION	
Gas, Cu. ft.	166,121,000
Oil, Gallons	108,249
BTU/BHP/Hour (Gas plus Oil)	6,430
% Fuel - Oil	8.1
Fuel Gas - 956 BTU/cu.ft.	
Fuel Oil - 143,200 BTU/gal.	
Fuel consumption guarantee - 7,200 BTU/BHP/Hr at Full Load (80 BMEP at Sea Level)	

In the manual arrangement, where the full governor travel is utilized for the gas control mechanism or oil control mechanism, it is necessary in the event of a gas shortage to position the gas control lever for whatever maximum gas quantity is available. With this gas control position fixed, the governor will then actuate the fuel pump linkage and supply the required quantity of liquid fuel for maintenance of full load operation.

Means have been developed for throttling the air so that the air-gas ratio is maintained relatively consistent at all load conditions, resulting in improved economy at partial loads.

In an MPC paper on Dual-Fuel Engine Performance and Economics, Ralph L. Boyer, vice president and chief engineer, The Cooper-Bessemer Corp., reviewed the developments by his company in both 2-cycle and 4-cycle gas Diesels and dual-fuel engines. He also discussed them in a paper before the SAE Annual Meeting in Detroit.

In the atmospheric type of 4-cycle engine the gas is allowed to enter the cylinder, already mixed with the air. In the Cooper-Bessemer type of engine, the gas is allowed to flow under extremely low pressure into the intake valve passages and the mixing takes place during the induction stroke. This gas flows into this space continuously, while the valve is closed, as well as when it is open. When the intake valve first opens there is, therefore, quite a pocket of raw gas in this area. The incoming air stream, however, completely mixes it so that a very thorough mixture of the two results in the cylinder. This gas injection means is shown in Fig. 4.

Perhaps the most important phase of the entire development has been that of the supercharged 4-cycle engine. In this type of engine it is necessary to time the injection of gas, since if allowed to flow continuously, it would be scavenging with a mixture and would therefore lose gas into the exhaust line. We prefer to inject the gas into the air stream, said Mr. Boyer, duplicating nearly as possible the atmospheric 4-cycle arrangement. The principle of such injection is shown in Fig. 5.

We are definitely able, said Mr. Boyer, to rate the engine at a higher bmep on gas operation than on oil. Preignition is unknown. Detonation is practically unknown on 4-cycle engines and is not particularly serious on the 2-cycle engines. In our own minds we differentiate between preignition and detonation, in that preignition occurs before the pilot oil is admitted, while detonation is an extremely rapid flame propagation during the ignition process. Our feeling, however, is that on the 4-cycle engines we are getting a very homogenous mixture which is of course more difficult to get on the 2-cycle type, since in a 2-cycle engine we must inject the gas after the ports have closed.

Cylinder peak pressures and exhaust temperatures are no higher with gas-Diesel operation than with oil operation and in fact tend to be a little lower. There is a definite improvement in smoothness of operation on gas as compared with oil and it is easy to tell by the sound of the engine which fuel is being used. There have been practically no mechanical troubles with gas-Diesel or dual-fuel engines over and above the normal experience with Diesel

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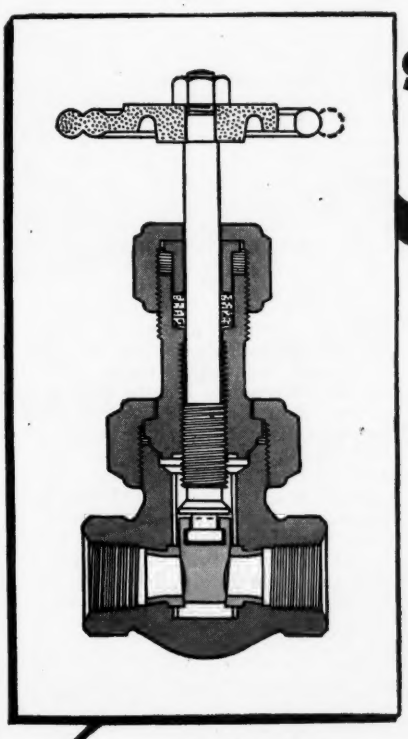

Operating men everywhere rate these valves as tops for general gate valve service including meter and gauge lines, drip and drain lines, etc. Series 9850 valves have drop forged carbon steel bodies and bonnets, rolled in 11½-13% chrome stainless steel seat rings which can be easily renewed, and a solid stainless steel wedge. A ground joint insures tightness between body and bonnet. The stuffing box can be repacked under pressure when the valve is open.

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Series 9850-F8 valves have 18-8 stainless steel trimmings and carbon steel bodies and bonnets.

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engines, since the engine doesn't know which fuel is being used. In some of the original engines, fuel consumption at light loads was not at all good. This, however, has been corrected until the engine is now quite efficient at all loads.

Any customer having gas available wants to burn as much gas as possible and reduce fuel oil to a minimum. The current popular fuel oil percentage is 5 per cent based on total Btu's consumed at full load. Even the 5 per cent has been quite an accomplishment when it is realized that around 15 per cent is required to keep the engine running completely idle.

Performance of Typical Installations

The first Cooper-Bessemer field installation of an atmospheric 4-cycle engine was at the Sulphur Springs Valley Electric Co-op. Inc., McNeal, Arizona, in 1945. This engine is a 15½-in. by 22-in., 8-cylinder unit with a sea level rating of 1095 bhp. The elevation there is 4160 ft, which, according to DEMA Standards, gives us 975 hp, or 685 kw. Table shows operating data as of November 1, 1948.

The first Cooper-Bessemer installation of a supercharged engine of this type was made at the City of Cherokee, Oklahoma, more than two years ago. It is on a much more variable load factor than the Sulphur Springs engine, this being a typical municipal load. The engine has been producing a bhp hr for less than 6000 Btu's. We ourselves, said Mr. Boyer, have been doubtful that the performance is quite as good as they say it is, but the fact remains they are in the business of generating power and selling it and are telling us exactly how many kwhr were produced by that engine and exactly how many cubic feet of gas they had to pay for as fuel. The evidence is that guarantees are being met by a large margin of safety.

Comparative Fuel Costs

While the dual-fuel engine is not limited to natural gas, having been used successfully for various other gases, including refinery gas, manufactured gas, sewage gas, propane and the like, a very high percentage of these engines has been used on natural gas. Figure 7 shows the relative cost of natural gas versus fuel oil. Since we seldom find industrial natural gas costing more than 65 cents per 1000 and since this compares directly with oil under 11 cents, it is apparent that even in the remote districts where natural gas is the most expensive that it can be today, very readily compete with fuel oil. In the gas-producing districts of this country, 20-cent gas is common, 10-cent gas not particularly unusual and 6-cent gas is an actuality in a large plant in the Southwest.

In order to permit a reasonably accurate picture for deciding whether a gas-Diesel or dual-fuel engine can compete, we supply curve sheets of the type shown in Fig. 8. Where gas costs a maximum of 65 cents, the dual-fuel engine, including its fuel oil, will save about $17,000 per year per 1000 hp. over the spark-ignition gas engine. Where gas costs only 10 cents, there is, of course, practically no saving. The advantage there lies purely in the convertibility of the engine to oil in case of gas failure. In Fig. 8, 65 cent gas and 14 cent oil will save $25,000 per year per 1000 hp. With the same price fuel oil and 10 cent gas, the figure goes to $54,000 per year.

More Typical Costs

At our Grove City, Pa. plant we pay 65 cents for gas and 13½ cents for oil. For each 1000 hp we therefore save $17,000 per year over gas-engine operation and $23,000 per year over oil operation. At the Jones Mills, Arkansas plant of the Reynolds Metals Co. they are today paying 6 cents for gas and 10 cents for oil. They are, therefore, not saving anything over straight gas-engine operation, but based on 4-cycle supercharged engine performance would save $40,000 for each 1000 hp over oil engine operation.

In oil field drilling, gas costs nothing. However, gas is frequently not available, particularly in wildcatting, and they must therefore start with Diesel operation. At these remote sites 14 cent oil is not uncommon. For each 1000 hp they therefore would save $60,000 per year, based of course on that many horsepower hours being developed during the year. The modern rotary drilling rig frequently has 2000 hp.

The standard low compression spark-ignition engine is never rated much in excess of 70 bmep. The atmospheric 4-cycle gas-Diesel is today rated from 80 to 85 and the supercharged version of it is rated at 120 to 125. As a matter of fact this supercharged gas-Diesel is capable of much greater overloads, even at this rating, than is the spark-ignited engine with its 70 bmep rating. We may safely say, therefore, that we have increased the power in a given size of engine by about 75 per cent. This engine requires therefore no more building space and no more foundations than its lowly rated competitor. Its cooling system is no larger. In general, the cooling equipment which took care of the 70 bmep engine will now nicely serve the new engine with the 70 per cent increase in rating.

Two-Cycle Engines

In their paper on the Two-Cycle Dual-Fuel Diesel Engine with Automatic Fuel Conversion, before the 21st National Oil & Gas Power Conference, ASME, Chicago, April, 1949, E. L. Conn, R. H. Beadle and G. A. Schauer of Fairbanks, Morse & Co. explained their two-cycle, pump-scavenged Diesel engines to which parts have been added so that the engine, without benefit of operator attention, will automatically convert from gas to oil or from oil to any percentage of gas up to 90-95 per cent. When running on gas, the 5-10 per cent of fuel oil is used to ignite and control the ignition of the gas.

To burn gas in this engine, it is necessary to add a poppet valve to its cylinder head, the valve being opened and closed once in each cycle after the exhaust ports have been closed. For ignition pilot fuel, injection plungers are installed separate from the main Diesel fuel injection plungers. Suitable camshafts for actuating these added valves are provided. Fairbanks, Morse dual-fuel engines are supplied in capacities from 325 bhp to 3500 bhp.

Two-Cycle Governing System

Governing system for these engines is shown in Fig. 1. It is essentially the same as on a standard Diesel, except that only half of the total governor travel is used when operating on Diesel fuel oil.

Governing on gas, the other half of the governor travel is used to control the position of a gas throttle valve. The main Diesel plunger is then at no fuel position, and only the pilot fuel plunger is operative to supply the pilot ignition charge.

Automatic conversion from gas to oil, or from oil to any percentage of gas up to 90-95 per cent is accomplished thus. The governor is used to operate a control shaft, which positions both the throttle valve and fuel pump racks. With the engine control handle then set in the "Run, Gas" position the engine will automatically run on gas if both the manual operated and hydraulically-operated gas valves are open; if not, the engine will run on Diesel oil. If sufficient gas is available, the injection pump control levers will move back and forth but will not engage the pump racks, for this portion of the governor travel is used exclusively for positioning the gas throttle valve.

However, if gas supply pressure drops to a value insufficient to maintain load and speed, the levers will move in to contact the fuel racks and the main Diesel pumps will supply fuel oil equal in amount to the gas supply deficiency. The gas throttle valve remains wide open whenever the Diesel pumps are operative. If the gas supply fails entirely or is shut off at the valve, the engine will then govern on Diesel.

The lube oil pressure actuated gas supply valve will close and thereby cut off the gas supply to the engine if: (1) The engine lube oil pressure is below a predetermined value; (2) the engine overspeeds; (3) The fuel oil supply, and thus the pilot fuel supply, fails.

Several engines in the field equipped with this system have operated over 12,000 hours without maintenance, adjustment, or change in delivery.

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ATOMICS

Temperature and Nuclear Reactions*

ONE OF the things about nuclear reactions that has puzzled those of us who are not nuclear scientists is the meaning of the extremely high temperatures that are supposed to characterize such reactions. In the Bikini atomic bomb tests, for example, frequent reference was made to temperatures of fifty and a hundred million degrees and many of the reporters and newspaper representatives who went along to witness the tests assumed from this that all the target vessels would be melted by the enormous heat.

Of course we know that this did not happen; in fact, scientists predicted that it would not happen. The multimillion degree temperatures, they explained, existed only at the very center of the explosion and the temperature gradient fell off sharply as the distance from the center of the explosion increased. The temperature that existed at the surface of the nearest target vessels was probably only a few thousand degrees and that, of course, lasted only for a very small portion of a second.

Notwithstanding this explanation, temperature of fifty and a hundred million degrees are still difficult to conceive in terms of anything in our own experience. Most metals melt at temperatures below three or four thousand degrees, indeed most of them are completely vaporized at such temperatures. Astronomers tell us that the temperature of the surface of the sun is only around 6000 to 10,000 degrees, C.

Then what is a million degrees? How can anything be so hot? As a matter of fact, the temperatures attained by the fission of uranium is very much higher than the temperatures mentioned. Theoretically the temperature attained in the fission of uranium has a value that can only be expressed in terms of *billions* of degrees.

The logical way in which to think of such temperature is to think of them in terms of kinetic energy. From thermodynamics we know that as the temperature of a substance is increased, the molecular movement of the atoms and molecules increases. At 500 degrees the velocity of sodium atoms is around a half mile per second. Increasing the temperature merely means increasing the kinetic energy of the atoms and molecules.

In an atomic bomb explosion we have the same relation between temperature and kinetic energy. When temperatures of millions or billions of degrees are referred to it merely means that the kinetic energy of the atoms is extremely high. If, in the case of the fission of uranium, the uranium splits up into two approximately equal fragments these fragment are blown apart and travel at a speed of around 300,000,000 miles per hour or over 80,000 miles per second.

The kinetic energy of the fission products, however, is not the only source of heat; gamma radiation of enormous intensity also is liberated at the instant of fission. This radiation exerts a terrible mechanical pressure—a pressure so violent that it is almost certain that the upper steelwork of the Alamagordo tower was destroyed by the *mechanical pressure of radiation* from the unlimited reaction of the U-235. The gamma rays, traveling outward at the speed of light leave everything behind for no material particle can attain that speed. It is a wind blowing at 670,000,000 miles per hour. Its impact is as violent, from sheer mechanical pressure, as the impact of a 16-shell.

It is comparatively easy to calculate the theoretical temperature of any nuclear, or for that matter, chemical reaction, if we know the velocity or energy of the particles. In nuclear reactions these are usually expressed in terms of Mev, that is millions of electron volts. In the following formula, the temperature, T, is in degrees Kelvin or Absolute; the energy of the particles, E, is in Mev.

Then, $T = 7.8 \times 10^9 E$

In the fission of uranium, the energy release is in the neighborhood of 200 Mev, so it is clear that the temperature attained is well up in the billions of degrees.

If these facts concerning the mechanism of heat production in nuclear reactions are clearly understood, there need be no mystery about the very high temperatures that these reactions bring forth.

*** This article is an abstract of an article in the July issue of ATOMICS magazine.**

As previously announced, the ATOMICS section which has appeared as a section of Power Plant Engineering and Power Generation since October 1945, is now being published as a new separate publication.

The new ATOMICS represents a greatly expanded service to those who are interested in the theory and applications of atomic energy. It will keep readers abreast with what is happening in the field of atomic power development, in the industrial applications of radioactive isotopes, and in the use of nuclear energy in medicine, biology, and agriculture. The July issue, in addition to the article abstracted on this page, contains other material on atomic energy of general interest, including the second installment of the course in Nuclear Power Engineering. The first installment of this course appeared in the June issue.

If you are interested in seeing this new magazine regularly, send in the attached coupon for a free copy of the June issue. ATOMICS will be published monthly, and as has been true of the articles which have appeared in the ATOMICS section of Power Generation, the articles will be kept on a practical understandable level.

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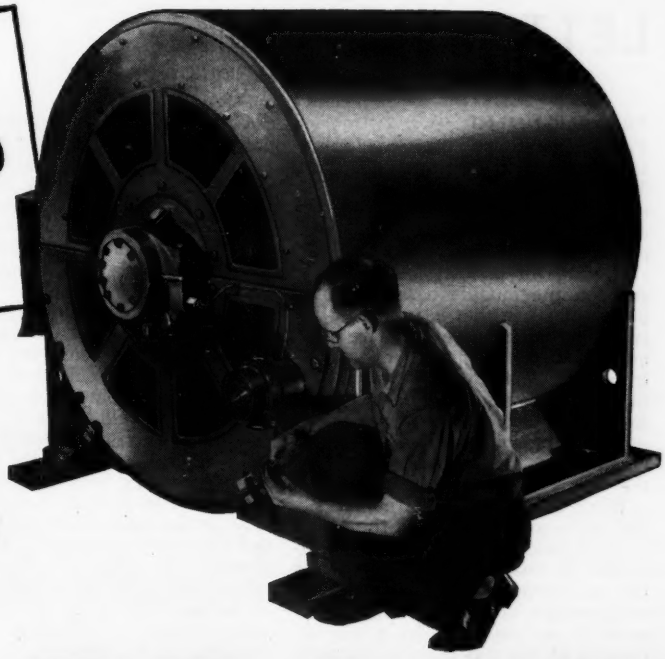

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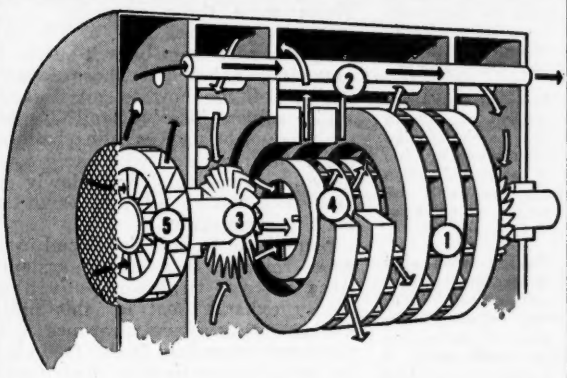
How Tube Cooling Works



Stator core (1) is surrounded by tubes (2). Internal fans (3) circulate air through ducts (4) in rotor and stator and around tubes, transferring heat to tubes.

External fan (5) drives outside air through tubes, removing heat and keeping tubes clean. All electrical parts are enclosed. Dirt cannot enter.

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LETTERS TO THE EDITORS

(Continued from page 53)

PIPE ALIGNMENT

THE ALIGNMENT OF PIPE joints for butt welding as described by Mr. Clifford T. Bower in the September, 1948, issue of POWER GENERATION reminded me of some of my past experiences.

Getting an ordinary C-clamp to stay on the outside of a couple of pieces of angle that is used to align two lengths of pipe is more than enough to try the patience of a patron saint. When angle iron is used to align two lengths, much better success is experienced when one piece of angle iron is used with two clamps, one holding each section of the pipe.

When the C-clamps are notched, the problem of tightening the clamp to hold the angle iron and pipe securely is much simplified. At best two men are required to attach the combination and many times their work is accompanied by profanity, ranging all the way from the innocuous to the mephitic.

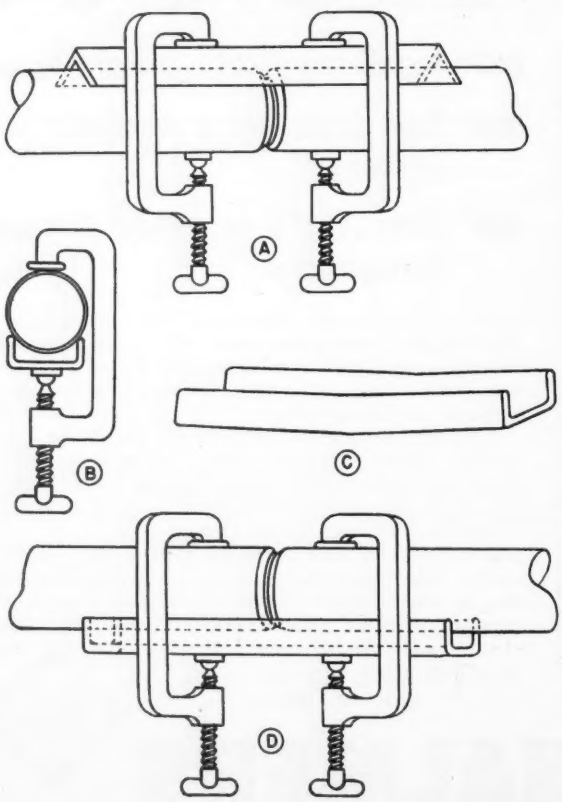
First choice should be an ordinary piece of channel iron of the proper size and a couple of C-clamps. This proves to be nearest to the ideal aligning device when working outside the shop. The channel iron is used as shown in the accompanying sketches. The only precautions are that there be no burrs on the ends of the pipes to be joined (this is automatically eliminated when the pipe ends are chamfered), and that the channel iron not be so large as to permit the pipe to strike its back. This precludes all of the trouble that goes with attaching the C-clamps, when the angle iron aligning device is used.

The welder may then choose whether to weld half way around the joint before removing the channel iron or to tack weld securely, then remove the "channel" before making the weld. A piece of welding rod is easily placed between the ends of the pieces of pipe to get the proper spacing before tightening the second clamp and then removed, giving the necessary gap which insures proper peneration. If convention, or the boss, demands it, chill rings may be used, but good welders sometimes feel that the use of chill rings casts a reflection on their ability.

A word of caution to the uninitiated: if the sides of the channel become heated to a red heat, as they may when using a torch, the channel iron will become bent when it cools and will soon be valueless for straight aligning purposes.

One man can easily attach the ordinary C-clamps and channel iron. Notching the jaws of the clamps is neither necessary nor beneficial. While perhaps not so plentiful as angle iron, channel iron of assorted sizes to fit pipes of various diameters often can be located in the plant scrap pile. When not available from this source, the convenience and the time saved would justify the purchase of a 2 foot or 3 foot length, and the boys working on the piping job would be grateful, too.

ALFRED W. GOULD



A—A fairly satisfactory way of aligning pipe for butt welding, using one length of angle iron and two notched C-clamps

B — An excellent method of aligning two lengths of pipe for butt welding. Two standard C-clamps are used with one length of channel iron

C—This shows what to expect from repeated heating at the middle of a piece of channel-iron as would result if heated by working too close with a welding torch

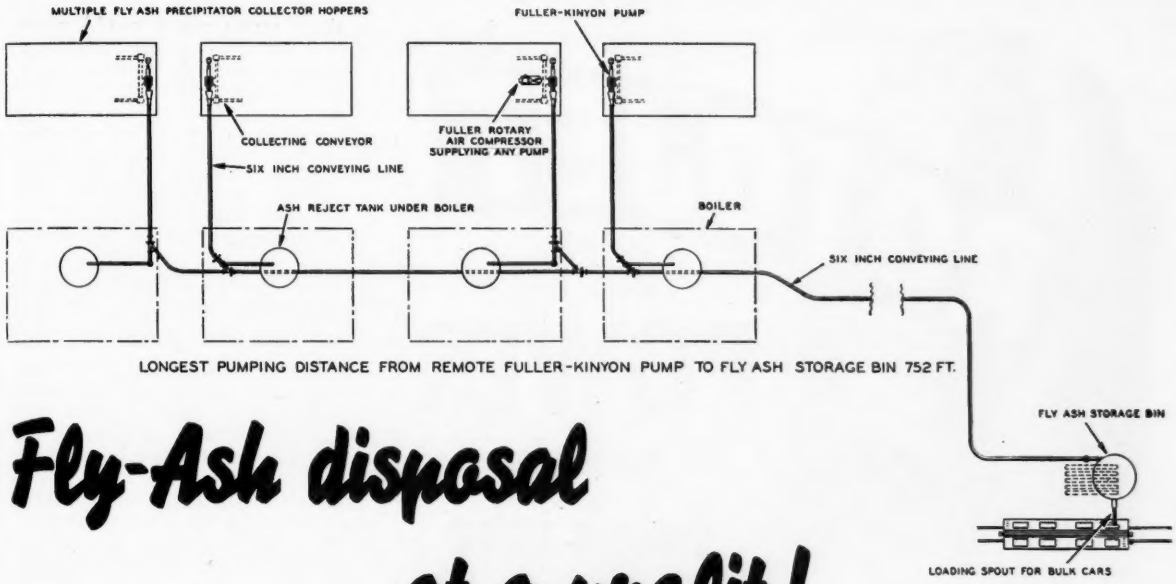
D — Make sure the channel - iron used with the C-clamps is small enough so that the pipe will be supported by the sides only and not make contact with its back

A SMUDGE

QUITE A SMUDGE appeared on windows, glass and furniture in air-conditioned areas. Inlet screens were all in order and had been cleaned regularly, they showed quite a collection of lint, soot, pollen and such, exactly what they were supposed to gather. Fan blades were dirty and sticky. Further checkup convicted the tallowpot, he had been anointing his boxes and bearings too well, excess oil had crept along to the blades. Too much didn't help any, was delivered as a darned nuisance with the air, besides slowing up fan efficiency like barnacles on a propellor. Watch out for this same gremlin on motors too, excess oil will work its sneaky way into insulation and leads, softening up resistance like a travelling salesman.

Certain traps of first class design and reputation were in difficulty, stopping-cleanout-reassemble and ditto repeato. Checkup on this cleanout showed it to be mostly molding sand. These units were serving eight-foot by twelve inch ironer rolls, every alternate one revolving and stationary, high pressure steam fed. That doggoned sand remained in the drums during fabrication and a goodly proportion is still there. There were three openings only, steam inlet-outlet and a 1½ in. plug. Pressure wont blow it out, and you daren't hammer those satiny shells. Tell me how to get it out? Will a solvent dissolve sand? Could the product be used as return boiler-feed? Meanwhile it will likely improve progressively and slowly a long time before all that earth is back to earth again.

Some little trouble developed in a good reliable feed-heater system. Single stage turbines provided plenty exhaust heat for this unit, having excess blade clearance and resultant steam loss. Boiler feed also by single-stage-turbine centrifugal two-stage pumps. Heater about 30 ft. above the pump floor, where gages showed delivered pressure when anyone went down to look. Delivery would stop without warning. Gages were given a 45 deg tilt readable from firing floor above, and helped some. But if heater level fell as little as 20 in., apparently the thirty foot head barely balanced feed temperature flashpoint, and would produce near-vacuum in suction lines. 205-210 feed seems to function fairly well. Incidentally, quadrant teeth


MULTIPLE FLY ASH PRECIPITATOR COLLECTOR HOPPERS
FULLER-KINYON PUMP
COLLECTING CONVEYOR
FULLER ROTARY AIR COMPRESSOR SUPPLYING ANY PUMP
SIX INCH CONVEYING LINE
ASH REJECT TANK UNDER BOILER
BOILER
SIX INCH CONVEYING LINE
LONGEST PUMPING DISTANCE FROM REMOTE FULLER-KINYON PUMP TO FLY ASH STORAGE BIN 752 FT.
FLY ASH STORAGE BIN
LOADING SPOUT FOR BULK CARS

Fly-Ash disposal at a profit!

CONVEY WITH FULLER KINYON PUMPS

Fly-ash need not be a waste-product, but can be turned into a profitable by-product. It's no longer necessary to flood your property with this material, as has been done by many large power-generating stations in the past.

It has been found that the use of fly-ash is beneficial in the manufacture of many concrete products, such as, for example, cement bricks and blocks, concrete soil pipe, and ready-mix concrete. Large quantities are now being purchased in various parts of the country by manufacturers of such products.

The Fuller-Kinyon Conveying System has been installed in several power plants for conveying dry fly-ash to storage, for shipment either in bulk in railroad cars, or packing in bags. This conveying system is dustless and economical, the material being conveyed, either hot or cold, through pipe lines. An excellent example of such a system is illustrated in the drawing above, recently installed in an Eastern generating station. Three Fuller-Kinyon Pumps are now installed, with a fourth to be installed later. Each pump is designed to convey hot fly-ash from multiple precipitator hoppers, at a rate of 18 to 26 tons per hour, (depending on the density of the ash) to ash reject tanks under respective boilers, or to ash storage, for commercial disposition.

A Fuller Rotary Single-stage Compressor serves all of the pumps. The pumps operate alternately, permitting an eight-hour accumulation of ash in each group of hoppers, to allow the respective pump to unload this accumulation in two hours or less.

If you have a fly-ash disposal problem, why not have a Fuller engineer make a study of your plant and make suggestions how to remedy the condition We'll be glad to do this, with no obligation on your part.

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P-107

ROTOJET Air-driven Motor Model 525 with swing-frame head and universal joint for 2⅝" to 3" I.D. curved tubes.

has the POWER to make tough tube cleaning jobs EASY

Power is the stuff that makes the new ROTOJET stand out from all other tube cleaners. It makes tough jobs ridiculously easy. Uses less air, too. Get a powerful, rugged ROTOJET, and no other cleaner will ever satisfy you. Air or water-driven models for practically any size straight or curved tubes

ELLIOTT COMPANY-ROTO DIVISION

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on these pump gages would wear off in a year from pointer vibration, a three-inch cartridge gadget made by Trerice has apparently worked a cure.

I could go on but this is enough for one letter. Maybe these will help some brother engineer and maybe he can give me the answer to the sand in the ironer rolls.

Toronto, Canada — A. E. RICHARDS

INDUSTRIAL STEAM TURBINE OIL SYSTEMS

(Continued from page 66)

be rinsed in several batches of hot water to make sure all acid or caustic materials have been removed.

Steam cleaning is preferable to acid or caustic cleaning because it does not get the tubes so clean. Copper is a catalyst and is very active when clean. Steam cleaning leaves an imperceptible film on the tubes, which reduces the catalytic action of the tubes; whereas acid and caustic cleaning expose the raw material.

Repainting Oil Tanks, Pedestals, etc.

When it is necessary to repaint interior surfaces of oil tanks, pedestals, etc. which have been in service for some time, the following procedure is recommended:

1. Cleaning

(A) After draining oil from the system, wipe parts to be painted with lintless cloths.

(B) Clean surfaces with petroleum spirits to remove all traces of oil. To check efficiency of cleaning, apply trichlorethylene or carbon tetrachloride to the areas to be painted. These substances dry rapidly if the surfaces are free of oil; if not, the surface remains damp. Repeat until all oil is removed.

2. Removal of Corrosion and Old Finish

(A) All traces of corrosion should be removed by wire brushing all rusty areas.

(B) Areas in which the old finish has flaked, powdered or blistered should be wire brushed to remove the loose paint.

3. Repainting

Apply paint either by spray gun or brush to the prepared surfaces. One or two coats to be used depending upon the type of paint used.

Allow paint to dry 96 hrs before using tank.

It is recommended that the turbine manufacturer be contacted and his recommendation obtained on paint to use and method of applying it.

In general, unpainted oil tanks of the fabricated construction may be difficult to clean due to internal partially welded ribs which trap oil back of them. The under side of the top of the oil tank usually can be painted on old installations satisfactorily. The same procedures rec-

DeLaval OIL PURIFIERS

CLEAN THE FUEL-- PROTECT THE ENGINES

De Laval Oil Purifiers at Tacubaya will remove by centrifugal force any dirt or other solids that may get into the stored fuel oil in spite of all precautions. They will restore the oil to the clean condition necessary to best engine performance. They will remove the impurities that could cause excessive abrasion and wear on cylinder liners and piston rings . . . they will assure maximum economy of fuel supply.

De Laval Oil Purifiers are available in a number of sizes to handle a wide range of capacity requirements, and as either a Purifier alone or as the "Uni-Matic," complete with integral pumps and, if desired, with heaters.

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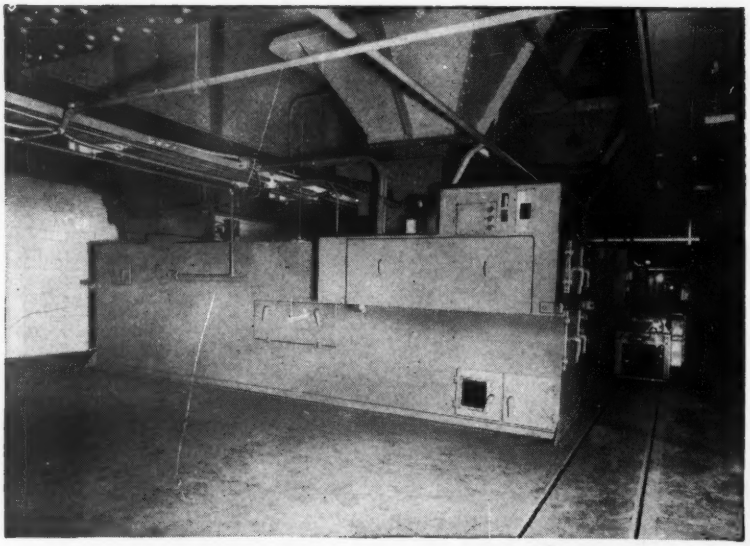
OIL PURIFIERS
for Lubricating and Fuel Oil



SEWAREN
KEYNOTES EFFICIENCY

RICHARDSON
DENOTES COMPLIANCE

Efficiency and simplicity keynoted the design and construction of Public Service Electric and Gas Company's new, 450,000 kw. Sewaren Generating Station. To keep building and operating costs down, four semi-outdoor type boilers supply steam at 1050° F., the highest temperature to be utilized commercially. To keep tab on coal consumption, 12 self-testing, elongated type, Richardson Automatic Coal Scales were installed.

An 1800-ton bunker supplies coal for each boiler. Four of the 12 Richardson Scales weigh and feed coal to three pulverizers, each of which is fed from either of two scales. When required, coal can be by-passed through a motor operated gate direct to the pulverizer or to a shuttle conveyor for delivery to adjacent boilers. Dust-proof construction of scales withstands pressure equal to 40 inches of water, confines coal dust to scale housing, contributes substantially to cleanliness of the plant.

For over 40 years Richardson Automatic Coal Scales have been helping central stations and industrials eliminate preventable coal waste and produce more power at less cost . . . a good reason for calling on Richardson when you plan to modernize your present plant or build a new one.

5867

For further details on Richardson Coal Scales, write for Bulletin No. 1143-G.

RICHARDSON
SCALE COMPANY, Clifton, N. J.
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ommended above should be employed.

Following are the results of survey of use of types of oils and filtration on industrial turbines produced by the General Electric Co.

Table showing approximate results of survey of GE industrial turbines, indicating acceptance of inhibited oils and need for greater use of oil conditioning equipment.

Units Installed	Oil Used: Inhibited	Oil Used: Conventional
Previous to 1942	15%	85%
Since 1942	90%	10%
Rating	Continuous Filtration	Periodic Filtration
500 - 1500	0	10%
2000 - 7500	5%	45%

COMING EVENTS

NAPE—The 48th National Power Show sponsored by the National Association of Power Engineers will be held at the Hotel Sherman, Chicago, August 22-26.

AIEE—The Pacific General Meeting of the American Institute of Electrical Engineers will be held at the Fairmont Hotel, San Francisco, August 23-26.

ISA—The Fourth National Instrument Exhibit to be held at the St. Louis Municipal Auditorium, St. Louis, Sept. 12-16.

NACE—A meeting of the South Central Section, National Association of Corrosion Engineers, will be held at the Adolphus Hotel, Dallas, Texas, October 3 and 4.

PEA—The Fall meeting of the Prime Movers Committee, Pennsylvania Electric Association, will be held at the Hotel Edison, Sunbury, Pa., Oct. 6 and 7.

ASTM—The First National Meeting of the American Society for Testing Materials to be held on the West Coast will be held at the Fairmount Hotel, San Francisco, October 10-14.

NMC-NME—The National Metal Congress and National Metal Exposition sponsored by the American Society for Metals, American Welding Society, Metals Branch, American Institute of Mining and Metallurgical Engineers and the Society for Non-Destructive holding combined annual meeting at the Public Auditorium, Cleveland, October 17-21.

ASCE—1949 Meeting of the American Society of Civil Engineers, Summer Convention, Mexico City, July 13-15; Fall Meeting, Washington, D. C., November 2-4.

Midwest Power Show—The 9th Midwest Engineering and Power Exposition will be held at Navy Pier, Chicago, November 11-16.

Obituaries

CHARLES HOSMER MORSE III

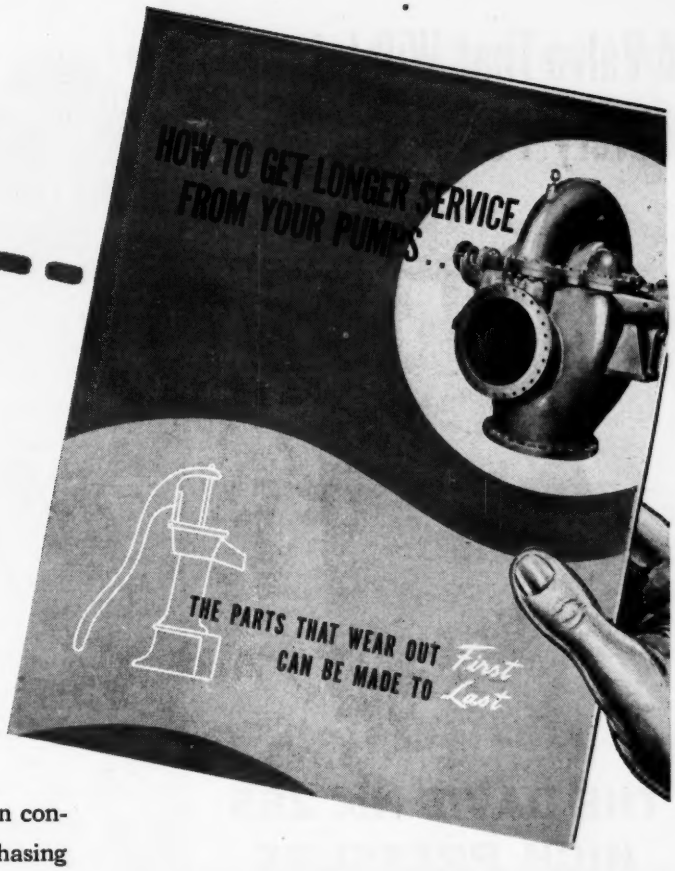
Charles Hosmer Morse III, Vice President in Charge of Manufacturing, Fairbanks, Morse & Co., Chicago manufacturers, and eldest son of Colonel Robert H. Morse, President of the Company, lost his life when the Company's big Lockheed Lodestar two motor plane crashed near Roanoke, Illinois, Saturday morning, July 9, 1949.

He first worked at the Beloit plant. Honorably discharged as a wounded veteran of World War I he rejoined the organization and worked in the Company's factories at Three Rivers, Michigan, Indianapolis, Indiana, and St. Johnsbury, Vermont. Later he was assigned to Company branches in many parts of the United States.

On June 21, 1946, he was elected Vice President in Charge of Manufacturing, with headquarters in Chicago.

FREE...

VALUABLE INFORMATION FOR PUMP USERS



Here is a new booklet, just off the press, that belongs in the files of every man concerned with operating, maintaining, or purchasing pumping equipment.

Case histories drawn from important industrial fields, show how pump operators and manufacturers have successfully dealt with those long-time enemies of pump life—corrosion, fatigue, and excessive wear.

You'll find these stories well worth reading . . . and they may suggest a solution to your own pump problems.

Meanwhile, if you are looking for ways to improve your pump installations, or are contemplating buying new ones, here is a tip worth remembering:

Most pump users agree that pump parts last longer when they're made of *Monel*, "K"* Monel, or "S"* Monel.* And that's not surprising, for these Inco Nickel Alloys have strength and fatigue resistance equal to that of structural steel. They are rustproof, hard, and corrosion-resistant as well.

These Inco "task" Alloys bring you other important advantages, too. For a more complete discussion of their desirable physical properties in pump applications, send for the new booklet . . . today.

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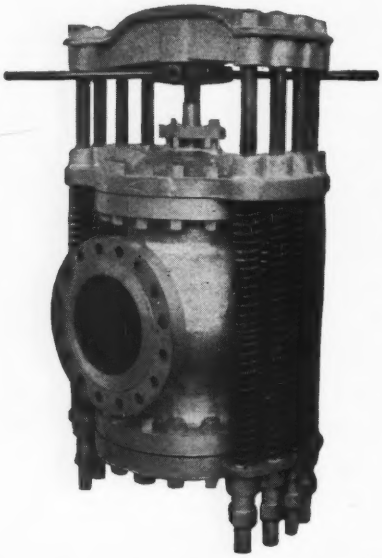
***Monel*... for minimum maintenance**

A Valve That Will Interest Every Power Engineer

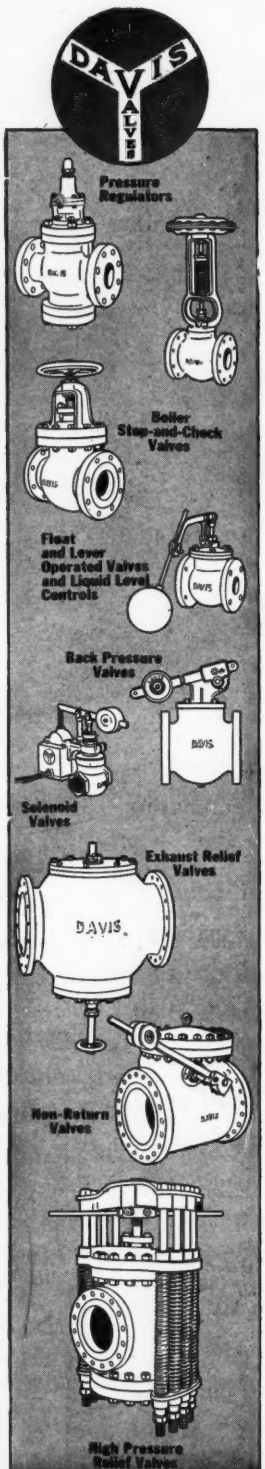


THE DAVIS No. 265 HIGH PRESSURE RELIEF VALVE

USES. — (1) For turbine relief on bleeder system. (2) For protection of any boiler room or process equipment by relief to atmosphere. (3) For relief of high pressure lines to low pressure lines at predetermined pressure. (4) For use in plants carrying multiple boiler pressures to protect lower pressure systems.

ADVANTAGES.—Multiple springs result in less spring accumulation . . . less build-up for maximum relief . . . less blowdown to close. Compact design with springs at sides reduces headroom requirements. Center adjusting screw available for quick, easy change of pressure setting.

BUILT TO REQUIREMENTS. Offered in sizes from 4" to 30" in semi-steel or steel with bronze or stainless steel trim. Test lever and hold-open device available when desired. Detailed information on request.



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CATALOG LIBRARY

This monthly list of the latest standard catalogs and bulletins is designed to aid the engineer in maintaining his permanent catalog file of engineering data. The items listed, unlike those under Helpful Bulletins, will appear each month except for additions and deletions determined by space requirements or by the manufacturers issuing the bulletins. Use the Helpful Bulletins coupon in requesting these copies.

BOILERS AND AUXILIARIES

201 **Working Pressure Data Card**—Maximum allowable working pressures for water tube and fire tube boilers are compiled in a handy reference table, Technical Data Card No. 113 A. It lists pressures in pounds per square inch for seamless and electric resistance welded carbon steel tubes or nipples for different diameters and gages of tubes conforming to ASME specifications. Chart covers 2 letter-size pages, is printed on firm stock, and punched for use in binder. The Babcock & Wilcox Tube Co.

202 **Blast Furnace Gas Burner Bulletin** —Said to be the first published on the subject. Bulletin No. 500, 4 pp, describes operation of these burners and discusses their adaptability for use not only with waste fuels, but also in combination with auxiliary fuels and by means of auxiliary fuels alone. Contains pictures of gas burner installations and cross section drawings of various other types of burners for waste and primary fuels. Peabody Engineering Corp.

203 **Heat Exchangers Data Book** — Illustrations and pertinent data on the company's complete line of redesigned heat exchangers are presented in Bulletin 1.1K1. This 8-page booklet presents cut-away views illustrating construction and line drawings showing sizes, dimensions and weights. Brief text on various applications of this all-nonferrous unit is presented. Ross Heater & Mfg. Co., Inc.

203A **Power Plant Equipment**—Catalog 200, 20 pp, presents a line of fans, fan stacks, tubular and duplex dust collectors, multicyclones, and recirculators. It discusses and illustrates applications for this equipment, explaining its operation and construction. Contains many photos and sectional drawings. Also lists well-known plants where this equipment is currently in use. Prat-Daniel Corp.

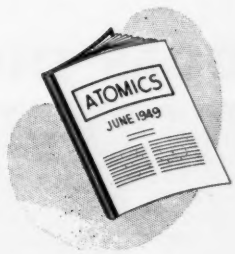
VALVES, TRAPS, PIPING

204 **Pipe Distribution System Data** — "Engineering Distribution Data for Underground Steam Distribution," is the title of Section 480-2, 34 pp, of practical usefulness to those who deal with problems involved in insulated piping distribution systems. It covers layout of the route and methods of estimating steam loads, includes steam flow charts and tables, and gives properties of steel pipe, copper water tube piping and saturated steam. Also gives specifications of steam and hot water distribution piping with prefabricated pipe conduit. It's illustrated with photos of field installations and industrial applications of insulated pipe units, also sketches showing method of making field closures. The Ric-Wil Co.

205 **Piping Materials Catalog**—Corrosion resistant valves and piping materials are covered in illustrated circular No. 320, 32 pp. Contains information on manufacturer's complete line of valves, fittings, fabricated piping and pipe coils to meet a wide range of corrosive conditions. Listing includes both photos and cutaway drawings of models, complete specifications, sizes and prices. Includes a description

A practical, easy-to-understand course in nuclear power engineering is now available in

ATOMICS



ATOMICS is published monthly for engineers. The timely articles appearing in each issue are essentially practical in nature—written for the average engineer rather than nuclear physicists. Andrew W. Kramer, the editor-in-chief of ATOMICS has been a pioneer in interpreting and translating the complex, highly technical material issuing from the laboratory into language any engineer can understand.

ATOMICS is the first regularly published journal of its kind. The monthly issues sparkle with engineering data, news of atomic power, articles of timely interest to those concerned with industrial process control, practical material for men interested in the technical and engineering aspects of nuclear reactions.

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USEFUL IDEAS FOR POWER ENGINEERS — A "how" book by the editorial staff of Power Plant Engineering furnishing hundreds of ideas on boilers, stokers, fuels, boiler operation, boiler water, refrigeration operation and maintenance, mechanical power transmission.

SECTION HEADINGS — Boilers, Furnaces, Stokers, Oil Burning, Chimney and Stacks, Forced Draft, Boiler Operation, Boiler Water, Boiler Operation Problems, Water for Power Plants, Fuel Purchase, Refrigerating Plant Capacity, Refrigeration Plant Operation, Brine Systems, Air Conditioning, Refrigerating Plant Maintenance, Mechanical Power Transmission. 240 pages, 6x9, 125 illustrations, tables and charts, $2.50.

PRACTICAL ENGINEERS OPERATING POINTERS — An excellent compilation by Power Plant Engineering editors of practical pointers pertaining to electrical equipment, turbines and engines, condensers, piping, pumps, etc. It shows you why things are done to save money and secure best results.

CONTENTS — Steam Turbines, Steam Engines, Condensers, Piping, Valves, Flow Measurements, Generators, Motors, Power Factor, Electric Wiring, Distribution Circuits, Fluorescent Lighting, Transformers, Electrical Plant Kinks, Safety Precautions, Distribution Circuit Problems, Piping Kinks, Hot Water and Steam Pumps. 239 pages, 6x9, fully illustrated, cloth binding, $2.50.

BOILER FIREMAN'S HANDBOOK

by Joseph R. Darnell

This book, which is the result of the author's thirty years of experience in power plant practice, will provide boiler firemen and power plant engineers with accurate, dependable data for solving many combustion problems. It also offers many helpful suggestions for the successful operation of various pieces of apparatus found in the power plant, such as temperature measuring and gas analyzing instruments, draft gauges, air preheaters, stokers, oil, gas and pulverized fuel burners, forced and induced draft fans, feed water heaters, and economizers.

CONTENTS: Fundamentals of Combustion. Why Flue Gas Temperature Goes Up When the CO_2 Goes Down. Sampling and Analyzing Flue Gas. Interpreting Flue Gas Analyses. Measuring Flue Gas and Furnace Temperatures. Coal Storage and Preparation for Use. Boiler Efficiency Calculated from Flue Gas Analysis and Temperature. Types of Air Preheaters and the Effect of Preheated Air on CO_2 Furnace Temperature and Flue Gas Temperature. Natural and Mechanical Draft. Draft Gages and the Measurement of Draft. Hand Firing Methods for Solid Fuels. Stoker Firing Methods. Fuel Oil Firing-Steam Atomization. Oil Firing Methods—Mechanical Atomization. Gas Firing. Pulverized Fuel Firing. Waste Fuels Firing. Heating Feedwater. Flexibility in Firing Equipment and Problems Involved in Converting from One Fuel to Another.

193 pages, 6x9, 139 illustrations, $3.00

POWER PLANT ENGINEERING QUESTIONS AND ANSWERS - 8th Edition — Here is a practical book arranged in convenient question and answer form. It covers several hundred knotty problems which arise from day to day and demand a definite answer on the spot.

CHAPTER TITLES—Power Plant Formulas, Boilers and Furnaces, Fuels, Combustion, Water Treatment, Water Heating, Pumps, Piping, Steam Engines, Steam Turbines, Condensers, Diesel Engines, Refrigeration, Compressed Air, Electrical Generators, Transformers, Electric Motors, Electrical Distributing Circuits.

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ONE *Baughman*

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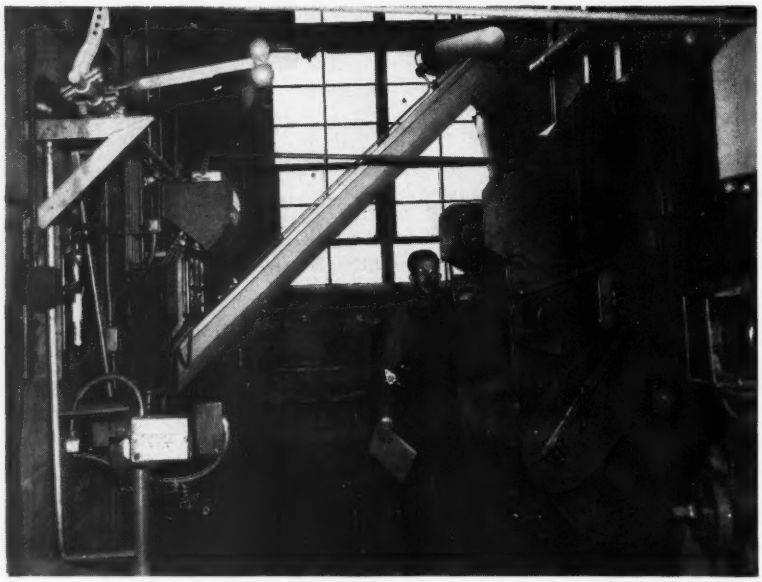
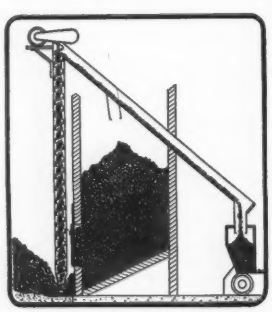


ONE BAUGHMAN "BIN-TO-STOKER" CONVEYOR . . . feeds several stokers. Illustration above shows one conveyor supplying two stokers. This low-priced MODEL No. 215 will pay for itself in 30 days through time and labor saved . . . Will last for years with a minimum of maintenance. Eliminates wheelbarrowing and shoveling—releases manpower for other duties—assures ample fuel at all times. Handles ½-ton per minute. 10 to 40 ft. lengths available. Easily installed in present boiler rooms and power plants. Takes up little room through wall or door. Precision engineered, the 215 Conveyor requires nominal support. Casing of 13-gauge, high-tensile alloy steel—17% stronger and 5 to 10 times more resistant to rust, corrosion and abrasion than ordinary steel. Heavy 9" screw electro-welded to seamless 2" pipe. All sealed bearings. Gears run in oil.

ONE BAUGHMAN CONVEYOR DOES IT ALL . . . Fills the coal bunker and feeds the stokers. Illustration at left shows how one Baughman "Vertical Screw Conveyor" will transfer coal into the bin, when it is dumped into a pit beside the building, and how this same conveyor transfers the coal from the bin to the stokers. One Baughman Conveyor does your entire coal handling job.



We welcome the opportunity to discuss your particular coal handling problems.

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389 E. ARCH STREET, JERSEYVILLE, ILLINOIS

of alloy metals used and a corrosion questionnaire. Also included are several pages of condensed recommendations on the selection of piping materials according to service requirements as well as a pictorial chart showing basic types of valves with names of their component parts. Crane Co.

206 **Steam Specialties**—Here is a collection of bulletins covering manufacturer's line of thermostatic steam traps, inverted bucket steam traps, float-thermostatic steam traps, radiator traps and valves, alternating receivers and lift traps, self-operated temperature regulators, air venting equipment, water blenders, strainers. All equipment is illustrated by photos, its operation and applications discussed, and its capacities, dimensions and prices listed. Sarco Co., Inc.

207 **Pipe Hanger Catalog** — Ninety-page Catalog 10-D is a valuable buyer's guide for adjustable pipe hangers and supports. Covers hangers for attachments to pipe and to structure, hanger assemblies, spring hangers, hanger rods, pipe supports and related equipment. Each type described and illustrated by photo and dimensional diagram and listed with dimensions and prices. Catalog also includes standard specifications, photos of installations and terms of sale. Indexed for quick reference; punched for filing in binder. Grinnell Co., Inc.

208 **Valves Bulletin**—A new catalog section 12-H describes all types of the company's cast steel pressure-seal bonnet valves. Information on choosing the best size valve for your service is given in one page of the booklet under the title, "Correlation of Valve Size and Pressure Drop." Design and construction advantages of the valves are given and tables of pressure and temperature ratings. Details of design including operating mechanism, body design, disk piston, and other features are explained. Dimensional details are given in tabular form accompanied by dimensioned line drawings. A standard materials specification table is presented. Edward Valves, Inc.

209 **Rubber Expansion Joints** — This 8 page bulletin AD 137 tells about the application, construction, styles, service and advantages of the company's line of rubber expansion joints. Other information given, includes "How To Order" and a table of dimensions which is accompanied by dimensioned line drawings. The bulletin is well illustrated. The Garlock Packing Company.

210 **Control Equipment** — General Catalog 001, 30 pp, is devoted to measuring and control equipment for water and sewage works, power and processing industries. Catalog illustrates and describes in detail: venturi tubes and meters, controllers, gages, manometers, pitot equipment. Includes capacity tables, dimensional data, specifications, layout drawings. Simplex Valve and Meter Co.

210A **Rubber Expansion Joints**—Four-pp Bulletin D features rubber expansion joints for handling many types of fluids under conditions of vacuum, pressure and temperatures to 250F. Gives specifications, sizes and tells applications. Also illustrates design principle of these joints. Goodall Rubber Co., Inc.

HEATERS, HEATING

211 **Space Heaters**—Bulletin 523, 12 pp, covers forced air space heaters, direct-fired by oil, gas or combination fuel and ranging in output from 400,000 to 2,000,000 Btu, for comfort heating, year-round ventilating, tempering make-up air, process drying and heat curing. It discusses their design and principle of heat distribution and lists 18 reasons why these heaters are recommended for open space heating. Includes specifications, capacity and dimension tables, sketches illustrating operating principles and construction details and photographs showing the heaters in use. Dravo Corp.

212 **Fan Heater Bulletin**—Here's a 2-pp illustrated bulletin (No. 109) on a new high pressure steam fan heater designed for complete utilization of both sensible and latent heat of high pressure steam. One page is devoted to description and photos of the heater. Other page con-

tains a sketch in color showing how the heater works. Niagara Blower Co.

213 **Heating Element Data**—Bulletin No. 20, 8 pp, contains detailed capacity and dimension tables on manufacturer's "Paracoil" heating elements. Illustrations and descriptions provide instruction for installation of heating elements and diagrams show six commonly used installation arrangements of hot water generation using these heating elements and storage tanks. Includes conversion table for steam and temperature conditions for determining capacity of any size heating element. Davis Engineering Corp.

214 **Steam Humidifiers**—Bulletin 1771 describes the company's steam humidifiers for automatically controlling relative humidity for the prevention of dry air damage to hygroscopic materials such as paper, leather, wood, cork, foodstuffs and other materials in storage or in process. The bulletin also describes the effect of relative humidity on human comfort and help and explains how maintenance of proper humidity will eliminate the fire and explosion hazards of static electricity where inflammable dust, vapors or liquids are present. Tables and charts are included on desirable relative humidity in various industries. Two useful sections of the bulletin are "How to Select," and "How to Install," both of which are accompanied by excellent line drawings presented in two colors. Armstrong Machine Works.

215 **Tubular Heat Exchangers**—Bulletin 916 is a particularly informative 32 page bulletin which has "just been issued." The bulletin describes the present designs of the company's tubular heaters, coolers, condensers and heat exchangers and their distinctive features. The various types of shells, tube bundles, stationary heads and floating heads are fully explained, together with statements of the particular services for which each is suitable. An additional helpful feature of the bulletin are tables of the characteristics of tubing, the thermal resistance of tubes and pipes of many different metals and alloys, and the specific gravity and pounds per gallon corresponding to degrees Baume and degrees API. Also presented is a chart of the specific heats of midcontinent crude oils and the charts for solving the MTD formula with correction factors for other than countercurrent conditions. The Griscom-Russel Co.

215A **Determination of Steam Quality**—Bulletin 41 is an 8-pp discussion, illustrated with charts and drawings, of procedures for accurate diagnosis of carryover in steam. The design and operation of proper sampling nozzles is explained along with the methods of testing steam quality. Data includes a table of dimensions of sampling nozzles for pressures above atmospheric for use in extra heavy pipes, and graph showing correction factors for ammonia and carbon dioxide in degassed condensed steam. National Aluminate Corp.

TREATMENTS, PREVENTIVES

216 **Protective Coating**—Bulletin 1540, 4 pp, is devoted to a corrosion resistant coating for cold, wet surfaces. Tells its protection against corrosive effects of natural fresh and salt water, cold acid and alkali solutions, acid fumes and atmosphere under shelter. Discusses in detail the use of this coating in water storage tanks and in condensers. Tells how coating should be applied and how to order it. Bulletin also includes photos and description of equipment recommended for use in applying the coating. The Dampney Co. of America.

217 **Corrosion Analysis**—Excellent working data on galvanic corrosion is contained in this 8-pp technical study of corrosion by concentraion cells, reprinted from Inco Corrosion Reporter, Vol. 3, No. 1. Discusses concentration cells, the metalion cell type, oxygen cell type, reversible concentration cells, their practical aspects and some rules for minimizing or preventing concentration cell corrosion. Illustrated with sketches showing conditions which accelerate corrosion. The International Nickel Co., Inc.

218 **Turbine Blade Deposit Study**—Identification and prevention of steam turbine blade deposits and boiler water conditioning to prevent such deposits are discussed in the new 16-pp illustrated Bulletin 28B7030. Describes x-ray diffraction methods employed by the company for identification purposes and the results obtained. Tables list the partial chemical analyses of deposits containing sodium disilicate, occurrence data on compounds found, composition of turbine deposits from turbines operating at various throttle pressures and temperatures, and comparison of compounds found in turbine blade deposits with boiler operating pressures. This is the 10th in manufacturer's series of engineering bulletins. Allis-Chalmers Mfg. Co.

219 **Boiler Water Manual**—Factual information on standard methods of applying chemicals in the treatment of water for boilers is presented in this 16-page technical bulletin, called Standard Method 122. Discusses pretreatment of raw water, application of chemical feeding to pretreating operations and both constant rate and flow responsive feeding direct to boiler drum and to feedwater systems. Also discusses condensate returns, flushing periods, condenser cooling water treatment and chemical tanks. Illustrations include photographs of two feeders and diagrams of the various methods described. Punched for filing in ring binder. Proportioneers, Inc.

220 **Water Conditioning Bulletin**—This is an eight-page discussion of water and chemicals developed for conditioning it to control scale and algae and inhibit corrosion. Describes several chemicals in detail, giving properties, composition and application. Also discusses special purpose chemicals. Wright Chemical Corp.

221 **Antifoaming Compound**—This new technical bulletin covers the company's latest product known as Antifoam 8. With the accelerated rate of operation in many power plants today, foaming from either chemical or mechanical origin has become one of the prime problems in boiler operations. This technical bulletin presents reasons for foaming and deals with

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the chemical causes, especially the application of antifoams to elimination of carryover from these causes. After discussing the causes for foaming the bulletin goes on to describe the proper dosage and feeding and results obtained from the use of Antifoam 8. E. F. Drew & Co., Inc.

222 Corrosion Resistance of Nickel Alloys—Technical Bulletin T-3 contains 44-pp of illustrated information on the resistance of high nickel alloys to corrosion by sulfuric acid. Although technical in nature, it is written so as to be readily understood by non-technical staffs. Performance of 30 nickel-bearing materials in a wide range of service is discussed, and there are 86 tables and 33 graphs and photos in addition to text. Problems involving a wide range of operations from the pickling of steel to petroleum refining and textile processing are covered. The International Nickel Co., Inc.

223 Magnesium Anode Data—General information on magnesium anodes for cathodic protection of industrial equipment, pipe lines and other metal structures is provided in 5 letter-size sheets. It covers applications of cast, packaged, flexible ribbon and extruded magnesium anodes. This bulletin gives composition of magnesium alloy used and includes ratings, dimensions, sketches and prices. Dowell Inc.

224 Anti-Foam Treatment — This 4-pp bulletin covers a new formula in powder form to be applied along with anti-scale treatment for improving steam quality, controlling scale in boiler feed system and sludge conditioning. It discusses the problem of steam contamination and explains the action of this polyamide anti-foam treatment. Tells how it should be applied and gives dosage requirements. A discussion of its advantages is accompanied by photos showing the effect of polyamide action on a boiling dilute Nacconol solution. Dearborn Chemical Co.

225 Boiler Corrosion—A 12 page article discussing the cause and prevention of corrosion in boiler systems is presented in Betz Technical Paper No. 111 titled "Corrosion: Its effect in Boiler Systems." The corrosive effects of oxygen, carbon dioxide, ammonia, hydrogen sulfide, acidity and physical factors are evaluated. Numerous illustrations, graphs and tables aid in understanding the article. W. H. & L. D. Betz.

226 Application Data Bulletin — Titled "The Aroclors," chlorinated biphenyl and chlorinated poly-phenyls, this booklet describes the unique properties which enables this material to fulfill certain requirements. The Aroclors have won a place in the electrical insulating field and in such widely differing applications as non-flammable hydraulic media, high-temperature and high-pressure lubricants, heat-transfer and expansion media, sealing compounds, adhesives and protective coatings, including plastics, pigments, lacquers, paints and varnishes. This booklet contains 28 pages and presents the combined information gathered by the company from what it believes it to be reliable and dependable sources. Monsanto Chemical Co.

ELECTRICAL

227 Electrical Diagram Guide—The purpose and use of electrical diagrams supplied with switchgear equipment are explained in Bulletin GET 1293A. It was written to help those who install, operate or maintain switchgear equipment make the best use of the diagrams that come with such equipment. Discusses in detail one-line, elementary, connection and interconnection diagrams. It tells their scope and uses and illustrates symbols used and common variations and explains ASA device function numbers and conventions. General Electric Co.

228 Transformer Buyers Guide—An excellent technical manual on instrument transformers is this 80-page catalog, GEA-4626B. Contains descriptions, photographs and index of ratings and construction for indoor and outdoor potential transformers, indoor and outdoor current transformers, outdoor metering outfits and portable potential and current transformers, according to cycles. Dimensions, prices and shipping weights are included with listing of each type, as is reference to manufacturer's bulletin dealing with that type of transformer. Index of types shows voltage and frequencies. Also included are tables showing mechanical and thermal limits of current transformers. Book has firm covers and ring binding for long-time reference use. General Electric Co.

229 Induction Motor Bulletin—A four-page illustrated folder, PB 7000-1, describes manufacturer's new two-pole, 200 to 3500 hp induction motor of fabricated steel construction, available in enclosed or separately ventilated types. Construction features are discussed in detail and illustrated with photographs. Elliott Co.

230 Synchronous Generators—This Bulletin, 05B6139A, describes construction features and electrical characteristics of engine-type synchronous generators in standard ratings from 25 to 10,000 kva and for standard speeds from 100 to 600 rpm, for Diesel, steam or gas engines. Also describes and illustrates mechanical construction of stators and rotors and discusses machine characteristics, ratings, voltages, frequencies, phases, temperature rises and operation at high elevation. Illustrations show typical installations. Available control accessories are listed, as are manufacturer's other products and territorial sales offices. Allis-Chalmers Manufacturing Co.

231 Magnet Catalog—Twenty-eight page Catalog CDM-2A is a handy ordering guide for stocked permanent magnets of cast and sintered Alnico and special magnetic alloys. Contains photos, dimensions and pull curves of many stocked magnets and drawings of all stocked patterns. Includes tables showing physical properties and tolerances of cast and sintered Alnico, also conversion table. Outlines procedure for requesting magnet design assistance from manufacturer. General Electric Co.

PUMPS, COMPRESSORS, ENGINES

232 Condensers—Bulletin 441-C, 28-pp, covers in detail every phase of manufacturer's line of condensers—their simplicity of design, accessibility, construction features. Illustrated with photos and drawings showing complete assemblies, parts, principles of operation. Bulletin also discusses emergency replacements, service and maintenance facilities available, and auxiliary equipment. Includes condenser tube data, pressure-conversion tables. Condenser Service & Engineering Co.

233 Chemical and High Pressure Pumps—Catalog 146, 30 pp, covers controlled volume pumps for chemical and high pressure service. Discusses their general applications, tells how they work, and explains manual stroke adjustment and automatic control. Contains photos and descriptions of these pumps in a wide range of capacities. Technical data includes capacity pressure selection tables, a three-color table showing materials of construction suitable for handling more than 175 chemicals. Also gives dimensions, shipping weights and provides a prepared form for requesting quotations. Milton Roy Co.

234 Compressor Selection Chart—Here's a new selection chart, based on normal applications handling air with atmospheric intake pressure. It simplifies selection of proper size compressor for average industrial use, with quick comparison between discharge pressure pounds per square inch gage and piston displacement cubic feet per minute and shows recommended compressor bore and stroke in inches. Chart covers two letter-size pages. Worthington Pump and Machinery Corp.

235 Air Compressor Lubrication Manual—Valuable information on air compressor maintenance is contained in this 40-page book on the lubrication of air compressors, second edition. Subjects treated include compressed air, compressors and related equipment, lubricating systems, compressor oils and their applications, lubrication requirements operating hints, oil requirements, storage and care of compressor oils, and safety precautions. All discussions are illustrated with large, clear photographs and drawings showing construction and operation of compressors, their lubricating systems, etc. Cities Service Oil Co. (In the South, Arkansas Fuel Oil Co.)

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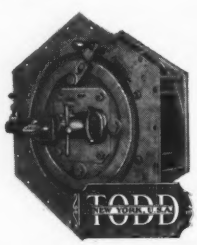

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235A **Steam Pumps**—This is manufacturer's collection of bulletins covering all types of centrifugal and reciprocating pumps for a wide range of industrial uses. Contains more than 80 pp in all and includes photos, dimensions, specifications, ratings and application data. Warren Steam Pump Co.

236 **Steam Engine Governor Data**—This new bulletin No. 502, describes the company's Type EN fully enclosed self-lubricated governor which is described as giving "precise, dependable engine speed control." Illustrations of the unit are presented and a parts list, accompanied by a sectional diagram is given. One section "Installation and Care" tells how to assemble governor to engine cylinder and how pulleys should be proportioned, the proper type of belt for use with the governor, correct lubrication procedure, method of packing and other data. Troy Engine & Machine Co.

237 **Turbine Catalog Collection**—This is a valuable collection of bulletins in loose-leaf form. They cover a complete description of manufacturer's solid wheel turbines and feature cross section drawings of typical units for both moderate and high steam pressure conditions. Also provides a description of an axial flow impulse, both single and multi-stage, and complete data on speed increasing and speed reduction gears. The Terry Steam Turbine Co.

INSTRUMENTS AND CONTROLS

238 **Combustion Instrument Catalog**—Twelve-pp Condensed Catalog 49-687 describes briefly and illustrates instruments and controllers for both boiler rooms and industrial processes. Equipment covered includes automatic controllers, meters for indicating content of flue gases, draft gages, flow meters, gas analyzers and recorders, and combustion testing equipment. The Hays Corp.

239 **Water Gages** — Eight-page Bulletin E-1 covers line of water gages for stationary and locomotive boilers, marine and refinery service and tanks for all pressures and temperatures. Listings include photos of all gages, sizes and construction details. Bulletin S-2, four pages, covers gage glasses, glass guards, sight flow indicators and related equipment. Ernst Water Column & Gage Co.

240 **Temperature Measuring Instruments**—For all those responsible for the safe operation of electric power equipment, this company has just issued a revised 34 page catalog ND4-33-461 describing the company's instruments for measuring the temperature of generators, motors, condensers, transformers, etc. The bulletin covers a wide variety of instruments, portable and automatic indicators, for checking in any order on temperatures. Reference also is made of new and specialized instruments for measuring in rapid succession a number of bearing temperatures. Leeds & Northrup Co.

241 **Combustion Control**—Bulletin 102-D describes this company's air operated combustion control. Containing 32 pages and bound in a heavy paper cover, the booklet describes completely the application to boilers fired with oil burners, stokers, to furnace draft control and points out its adaptability to any plant layout. Descriptions of the controllers themselves along with integral parts of the units are given. Typical installations of pulverized coal fired boilers are presented in a separate section of the bulletin. Installations on stoker fired boilers and on oil fired units also are given. Bailey Meter Company.

242 **Boiler Water Level Control** — Bulletin 487 describes completely the installation of boiler water level control equipment at the Blackhawk Generating Station, Wisconsin Power & Light Company. Photographs of the installation are presented as is a schematic layout of the entire station along with tabulated significant data. A large, full-page cross section of the B & W Type FH integral furnace boiler is presented and other drawings and photographs show the accompanying equipment. Northern Equipment Company.

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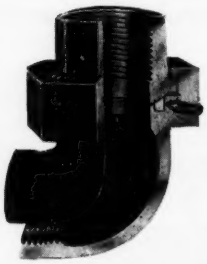

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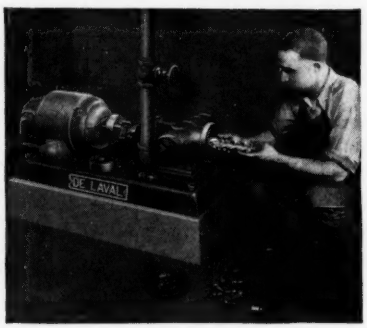

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243 **Multiple Signal and Alarm Systems**—Panalarms, multiple signal and alarm systems adaptable to all types of industrial and power plant applications, are described in 12-page, letter-size, illustrated Series 300 Panalarm bulletin. Gives details of operation, shows types for panel and well mounting, wiring circuits, operation sequence, dimensions of units. Shows how Panalarms indicate by light and horn signals, acknowledging button, for normal and abnormal conditions. Systems are supplied in multiple units up to 12 in single cabinet; extra space for spare units; provisions for future additions; simple field wiring. Price list included. Panalarm Products, Inc.

244 **Instrument Handbook**—"Modern pH and Chlorine Control" is a 100-pp catalog containing a great deal of valuable information in addition to covering manufacturer's line of scientific instruments and accessories. It explains the meaning of pH control, the electrometric and colorimetric methods of determining pH, and gives values of common acids, bases and foods, as well as maximum capacities of buffer systems. It also discusses in detail the applications of pH and chlorine control in air conditioning, water treatment, boiler water and many other industrial applications, recommending instruments and solutions. Instruments are illustrated by photograph, their functions described and sizes and prices given. W. A. Taylor & Co.

DUST COLLECTING

245 **Dust Collectors** — Dust collecting equipment for power plants, foundries, cement plants and similar industries is the subject of Bulletin No. 1428, 26 pp. Contains many photographs of installations, also photos showing equipment being tested in company laboratories. Discusses services offered by manufacturer in analyzing individual installation requirements and recommending equipment for the job. American Blower Corp.

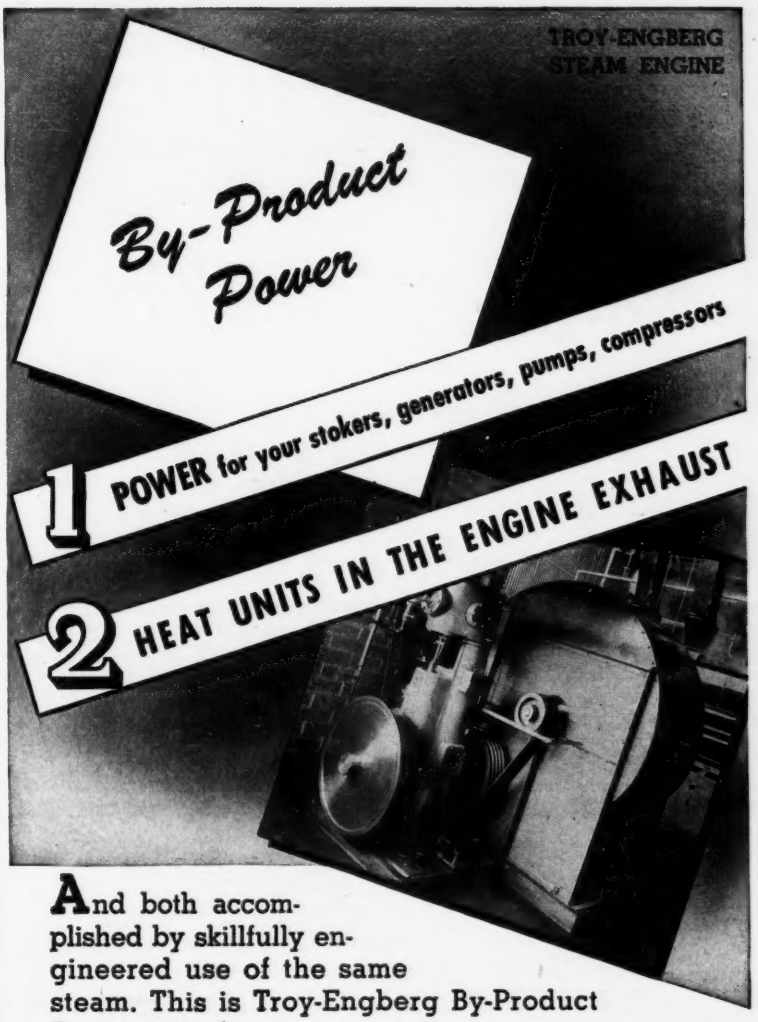
246 **Filter Catalog**—Manufacturer's line of filters for air and other gases, liquids, chemicals and special applications is presented in 44-pp Form 450. Its pictorial index is followed by a brief discussion of the applications of pipeline filters, air intake filters, liquid filters and ventilation and air conditioning filters. Each type illustrated and described in detail. Capacities, specifications, sizes given. Includes layout drawings, a listing of some of the filtering media available, installation data on panel filters, and selection chart for dry type filters. Dollinger Corp.

MATERIALS HANDLING

247 **Continuous Weighing of Dry Materials**—Bulletin E4-550 describes the company's new meter for continuously weighing and totalizing the flow of dry materials on conveyor belts. The meter can also be used for the automatic proportioning and controlling of dry or liquid feeders for secondary ingredients. The bulletin describes how the device operates, how it is constructed and gives various features. A double page spread, printed in two colors, presents a typical installation of the unit on a belt conveyor. Blueprint type drawings illustrate various applications for the continuous weighing and/or controlling and proportioning and flow of dry or liquid materials. Builders-Providence, Inc.

248 **Dry Materials Conveyor** — Bulletin F-H-1 describes this company's revolutionary type of conveyor designed for the handling of fine, dry materials. The book, which contains 12 pages, presents excellent installation views of the conveyor, and also drawings which illustrate construction and method of operation. The bulletin points out that the conveyor has no moving parts and that it has no hazards to workmen, is silent in operation, requires no lubrication and can pass around obstacles. Fuller Company.

248A **Coal Scale Data Book**—The answers to a power engineer's questions on coal scales are provided in this excellent 48-pp book, Bulletin 1143, covering scales for recording weight of coal consumed by individual boilers and weight of coal receipts from ship, car, truck or storage. It is generously illustrated with photographs of models and accessories and actual plant installations and contains all necessary engineering drawings, dimen-



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sional data and detailed specifications. Construction features and operation of weighing and feeding systems are described. Richardson Scale Co.

MISCELLANEOUS

249 **Refrigeration Condenser Catalog** — Designated as Bulletin RC-1, this 24-pp illustrated catalog covers ammonia and freon refrigeration condensers of horizontal and vertical construction. Includes specifications, dimensions and applications according to type. Lists weight and prices of available models and includes property tables for refrigerants and safe external working pressures for steel tubes. Sketches and line drawings show construction details and arrangement of units; photos show many installations. Henry Vogt Machine Co.

249A **Pump Packings**—Packings for use on reciprocating and centrifugal pumps are illustrated by photo and described in this 4-pp folder. It covers packings for practically all services and includes a table of recommendations to facilitate selecting the right packing for any particular application. Johns-Manville.

250 **Industrial Insulation Catalog**—Mineral insulations for practically every purpose are covered in this 20-pp illustrated catalog. It describes in detail insulating cements for both high and low temperatures, high temperature block insulation, block finishes, felts, blanket insulation, pipe coverings, loose wool, weatherproofing and stack paints. Includes information and what each class of insulation is for, what it can be expected to do, how it's applied, how it's packaged and, in most cases, how much it costs. Discusses requirements of a good insulation and tells how these products meet the requirements. Forty-Eight Insulations, Inc.

251 **Cooling Towers**—Double-flow cooling towers are featured in 20-pp Bulletin DF. It discusses the principle of double-flow cooling, the mechanical equipment utilized, construction features of a tower of this type, water distribution, coil shed, and safety factors. Recommends sizes for different applications and includes photos of many installations. The Marley Co., Inc.

252 **Concrete Floors Q & A** — A new booklet titled Lumnite Concrete Floors—Corrosion Resistant and Heat Resistant, has just been published. The detailed information contained in this booklet brings up to date, the service experiences and late developments in this field. The information covers methods and materials used in placing corrosion resistant concrete in a wide variety of industrial applications. Typical uses of corrosion resistant concrete are listed for many industries and also given, are the answers to a number of questions often asked about it. A section on placing and finishing corrosion resistant floors will be helpful to prospective users. Lumnite Division, Universal Atlas Cement Company.

CRUSHERS

253 **Coal Crushing, Sizing** — Bulletin 3007 describes the company's Bradford breaker a coal crusher, sizer and scavenger. The bulletin presents drawings of the breaker, tells how it works and then presents the complete story of its operation at the coal mine and coal cleaning plant at the By-Product Coke Plant and at the Power Station. The back section of the catalog presents engineering information on capacities, dimensions and dimensioned line drawings. Pennsylvania Crusher Company.

254 **Coal Crusher**—In this 8-pp bulletin a rolling ring crusher is presented as a solution to the problem of uniform stoker coal. Describes the special features of this crusher, emphasizing its shredder designed to split coal rather than crush it. Gives speed, capacity, weight and dimensions of available models and illustrates principle of operation. Also contains photos of parts and several complete installations. American Pulverizer Co.

New ENGINEERING BOOKS

Nuclear Radiation Physics, by R. E. Lapp and H. L. Andrews. First edition. Size, 5¾ by 8¾ in., 480 pages. Published by Prentice-Hall, Inc., 70 Fifth Avenue, New York 11, N. Y. 1948. Price $6.00.

Most people date the atomic age from the day the startling news of the bombing of Hiroshima crashed down upon us. To nuclear physicists, however, this event was an end rather than a beginning because, physicists had been concerned with questions of atomic energy for a great many years. Indeed, it all started in 1896 with the discovery of radioactivity by Henri Becquerel. This discovery and the brilliant work of Pierre and Marie Curie two years later in the isolation of radium first gave man an inkling of the enormous forces bound up in the heart of the atom. From that time on his efforts towards releasing the power in the atom have been unending. The entire first quarter of this century was spent in accumulating data and developing experimental techniques and it was only on December 2, 1942 that the nuclear physicists knew that they had arrived at a successful solution of the problem. On that day the first nuclear reactor went into operation at the University of Chicago.

With that flowering of knowledge, information that had previously been of concern to only a few specialists became pressing problems of many people in their everyday life. Today we are all more or less conscious of atomic energy and there is a great need for information of a character that the average intelligent individual can understand.

This book by Lapp and Andrews is an excellent example of the type of information that is needed. It is simple written without too much mathematics and tells the story well. The authors have an excellent vantage point from the very center of activity in atomic sciences, and have utilized to give a well-balanced, completely up-to-date picture of the entire field of nuclear physics.

The book is not intended for specialists; rather, it is intended for the large number of engineers, technicians, medical men and others who need to know the broad outlines of nuclear physics without pursuing the mathematical intricacies of the detailed theory. With the needs of this group in mind, the authors have included background material from other branches of physics in the first few chapters. Perhaps the most outstanding feature of the book is the treatment of the new field of health physics that has been the inevitable adjunct to the large scale production of radioactive material.

As pointed out in the preface, the book is the outgrowth of a war-time training manual in radiology. The deft manner in which concepts are presented is evidence of much trial and revision in the light of student reaction.

The book is provided with an excellent index and is well illustrated. From every standpoint this book may be highly recommended as an authoritative and readable text in this newest of human endeavors.

One of the authors, Dr. Lapp is also the author of the recent popular book, "Must We Hide?", devoted to a discussion of atomic weapons.

• • •

Conveyors and Related Equipment, by Wilbur G. Hudson; Second Edition; 468 pages; illustrated; size 6 by 9 in.; cloth binding; published by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y. Price $7.00.

During the past 5 years, the first edition of this book has become a classic in the industrial field; in fact, it has been the only book giving all in one place the information needed for buying, equipping, operating and maintaining all types of conveyors and their related devices. The second edition is even better than the first for it includes details on many of the developments that have been taking place since the first was published.

This book is a distillation of the 40 years' experience of Mr. Hudson in the field of materials handling in such varied capacities as Superintendent of Construction, Chief Engineer, Contracting Engineer and Consulting Engineer. For years he was connected with one of the largest manufacturers of conveying equipment in the country and has been consultant on conveying problems for many nationally-known

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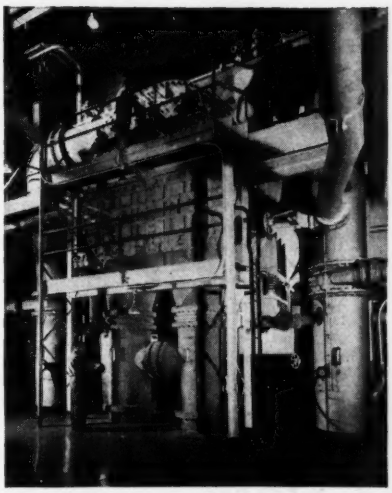

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organizations. His many articles on this subject in **Power Plant Engineering** and **Power Generation**, during the past 5 years, have clearly demonstrated his thorough knowledge of the field and his sound enginering judgment. It is pleasant to see the work of an able man, embodied in a textbook like this, appreciated to the extent that a large edition of his book is sold out completely within five years; but this recognition is well warranted by the high quality of the book.

Mr. Hudson aims to make the book useful to all those who seek information on the kind of equipment to use to best advantage—to the student enginer, to the architect, consultant and plant engineer. As he points out, this necessitates a number of compromises. Therefore, he has assumed that the student, through study of the catalogs and other matter furnished by the manufacturers, is familiar with the different types of equipment and in a general way with their applications. Perhaps, he says, it is more important to note their misapplications, but that unfortunately, comes through painful experience. Although many of the catalogs of 30 years ago seem to show the same types of equipment we have today, actually great progress has been made and more is to come. This is all reflected in the Second Edition.

Not only does this edition contain the previous material on the screw, flight, bucket and other types of conveyors and elevators, all brought up to date, but it contains some new information not included in the first edition. There is an entire chapter, for example, on unit loads, covering the handling of boxes, bags, package materials and so on as distinguished from pulverized, granular and lumpy materials. Handling of unit loads involves use of roller conveyors, belt conveyors, chain conveyors of various types, tram-rails and monorails, also various recently developed forms of trucks, tractors and trailers.

The subject of pneumatic and hydraulic conveyors has developed tremendously during recent years, and this too is fully expanded in this new edition. There is new and interesting information on the belt conveyor, because recent technical improvements have made them suitable for far greater lengths and capacities.

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(Continued on page 132)

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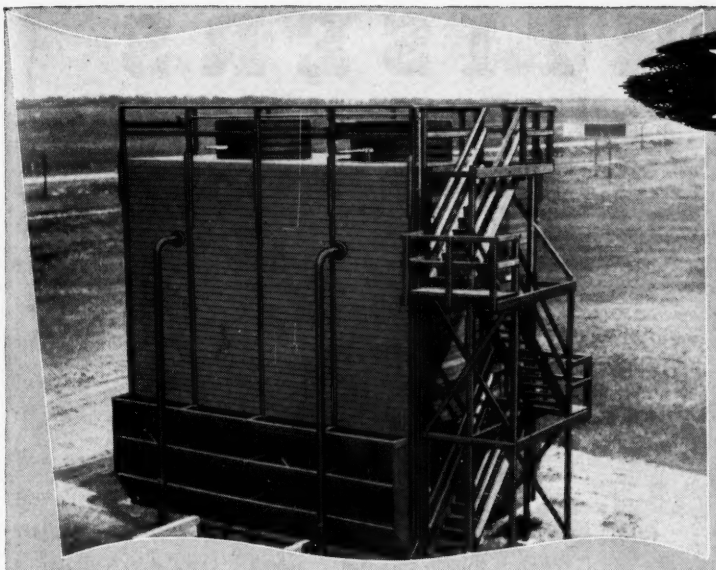

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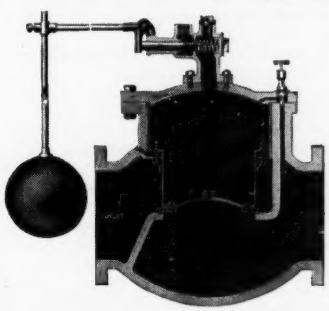

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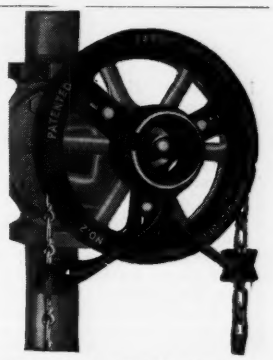

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Hagan Corporation 12-13
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Hall Laboratories, Inc. 22
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Hays Corporation, The ..... *
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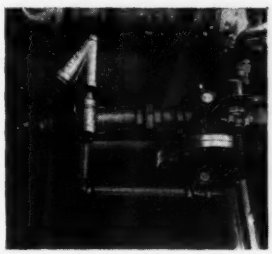

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No matter how carefully you select and locate the unit heaters to fit the job to be done, complete satisfaction cannot be assured unless you also take care of the vital factors:

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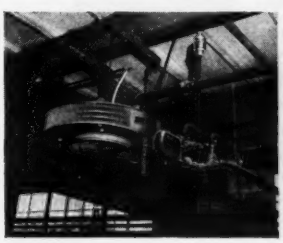
OR BETTER YET — ASK THE SARCO MAN NEAR YOU



At Broadvue Motors, Cleveland, Ohio—large doors let in cold at irregular intervals. Here Sarco Electric Thermostat and Float Trap keep the rooms comfortable without unnecessary heat.

Down blast unit heater dispels mist in dye room. Sarco Float Thermostatic Traps and Sarco Strainer ideal for continuous jobs like this.

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IMPROVES PRODUCT QUALITY AND OUTPUT

NEW ENGINEERING BOOKS

(Continued from page 128)

metallic powders recently has forced our attention to the dust explosion risks in industrial installations and these are covered in a new chapter.

One of the principal features of the book is the number of charts, curves and tables of data such as dimensions, capacities and so on, making it possible to calculate details of conveyor design. Wherever possible, typical examples are worked out; and as much as possible is said about cost of conveying equipment and its operation. There is a very good chapter on power plant coal and ash handling with a number of instructive installations; a section of this covers engineering a steam-plant coal-and-ash handling installation.

Chapter 21 covers some unusual problems and their solutions, which are outstanding. There is a discussion of tricky materials; for example, carbon black pellets and sulphur. Data on applications and limitations of each type of equipment are given, alternate solutions of various problems and data to help in getting proper equipment for a particular job—in short, everything to tell whether the conveyor will "deliver the goods."

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The Universe and Dr. Einstein. By Lincoln Barnett with an introduction by Albert Einstein. First Edition; size 6 by 8¼ inches; illustrated; cloth. William Sloan Associates, 119 West 57th Street, New York, N. Y. 1948. Price $2.50.

This little book is an attempt—a brilliant attempt—to describe the universe as it now appears in the light of modern scientific and cosmological theory. If any reader of this magazine should wonder why we review a book dealing with the universe, in a publication devoted to the subject of power engineering, perhaps the simplest and best explanation is, that the universe is nuclear energy. For with the exception of the earth on which we live and its sister planets, almost everything else that we can see and measure in the universe results from manifestations of nuclear energy.

Our own sun is a nuclear type of engine. It is a vast thermonuclear furnace with walls of intensely hot gas, held in place by enormous gravitational forces. It is interior hydrogen being converted into helium through the carbon-nitrogen cycle with resulting temperatures 20 million degrees and pressures around 150 billion atmospheres.

We need not, therefore, offer any apology for reviewing this excellent book by Lincoln Barnett.

The universe Mr. Barnett describes is far removed from the world perceived and bounded by the five senses. It is not substantial or palpable or mechanical. Its basic laws are those discovered by Albert Einstein.

The book begins, properly, with a consideration of the atoms, electrons, energy quanta—the fundamental building blocks of which the universe is built. This is followed by a discussion of the views which science now holds about space, mass and time, and their relativity to the observer. The final section of the book describes what it is possible to say about the structure of the universe as a whole, and what may be looked for in the future from Dr. Einstein's last, greatest and unfinished work—the Unified Field Theory.

Strangely enough considering the abstruse nature of the subject, Mr. Barnett's book is one that can be read by the intelligent layman. Those with some background of modern physics will find it delightful because it co-ordinates many related matters in such a way as to give one a better understanding of the whole.

The book is honored with a foreward by no less than Dr. Albert Einstein himself. "Lincoln Barnett's book," says Dr. Einstein, "represents a valuable contribution to popular scientific writing. The main ideas of relativity are extremely well presented. Moreover, the present state of our knowledge in physics is aptly characterized. The author shows how the growth of our factual knowledge, together with the striving for a unified theoretical conception comprising all empirical data, has led to the present situation—which is characterized—notwithstanding all successes—by an uncertainty concerning the choice of the basic theoretical concepts."

Lincoln Barnett, the author of this splendid little book, is a 39 year old native of New York who was educated at Horace Mann School and Princeton, and received his master's degree from Columbia University School of Journalism in 1932. From 1931 to 1937 he was a reporter on the city staff of the New York Herald Tribune. After this he went to work for Life magazine, as a staff writer and as an associate editor. In 1946 he left Life to devote his time to writing, and a great deal of his thought and effort since then have gone into this present volume.

It is curious that a book of this character should have been written by a man whose basic field of interest has not been technical. Throughout the entire volume he displays a marvelous grasp of fundamental physical principles. Never condescending, the discussion retains the integrity essential to its subject matter, yet the book is understandable and easy to read. Mr. Barnett has set his hand to one of the most difficult conceivable writing assignments and brought it off brilliantly.

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Standard Welding Terms and Their Definitions; also Standard Master Chart of Welding Processes and Process Charts; 50 pages; illustrated; size 6 by 9 in.; paper binding. Published by American Welding Society, 33 West 39th St., New York 18, N. Y. Price—Terms and Their Definitions, $1.00 per copy; copies of Master Chart, 35 cents per set of 5, $1.25 for both if purchased together.

To formulate a suitable, standard terminology for welding, the American Welding Society, after four years of intensive effort, has just published this book. This standard contains more than 500 terms and 57 illustrations. Its preparation involved defining many basic concepts and providing proper distinction between related concepts such as "fusion," "penetration" and "bond"; "bead weld" and "weld bead"; "backing weld" and "back weld"—to cite only a few.

An important aspect of the work was the necessity to verify whether or not basic terms are equally applicable to all welding processes. The preparation of a Master Chart of Welding Processes listing all 37 welding processes in commercial use today, and Process Charts comparing these processes on the basis of similarities and differences of twenty-four fundamental characteristics important in production welding, proved very helpful. On the basis that these charts would be equally helpful to users of welding, they have been issued concurrently with the Standard Welding Terms.

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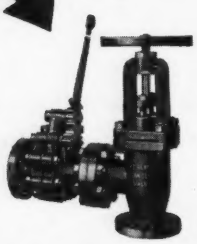

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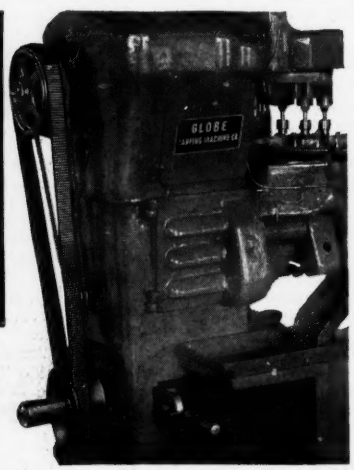

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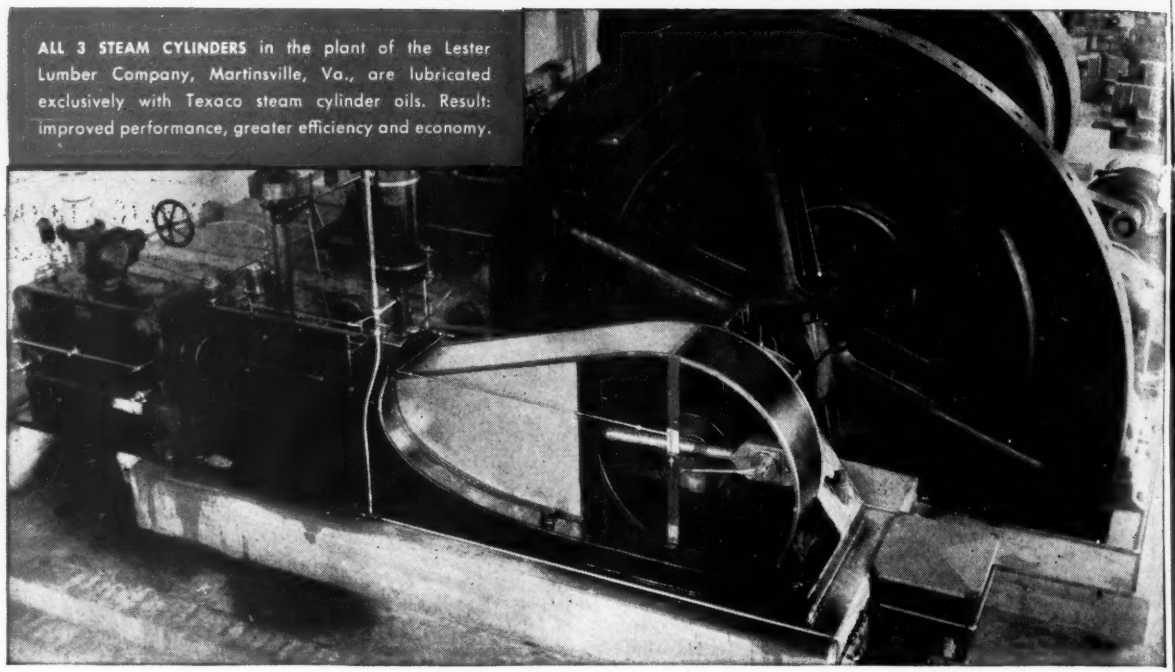

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